Nuts and Bolts of Integrating Monitoring and Modeling into Smoke Messaging

Leland Tarnay

2018 IASC

Parameters/Context: Not an “ARA-lite” Class

(there’s no such thing)

- If you have a wildfire that’s growing fast, or likely going to, call an ARA
- If you have a small Rx fire (less than 100-200 tons PM2.5/day)
- Large scale Rx Fire (e.g., more than 100-200 tons/day*

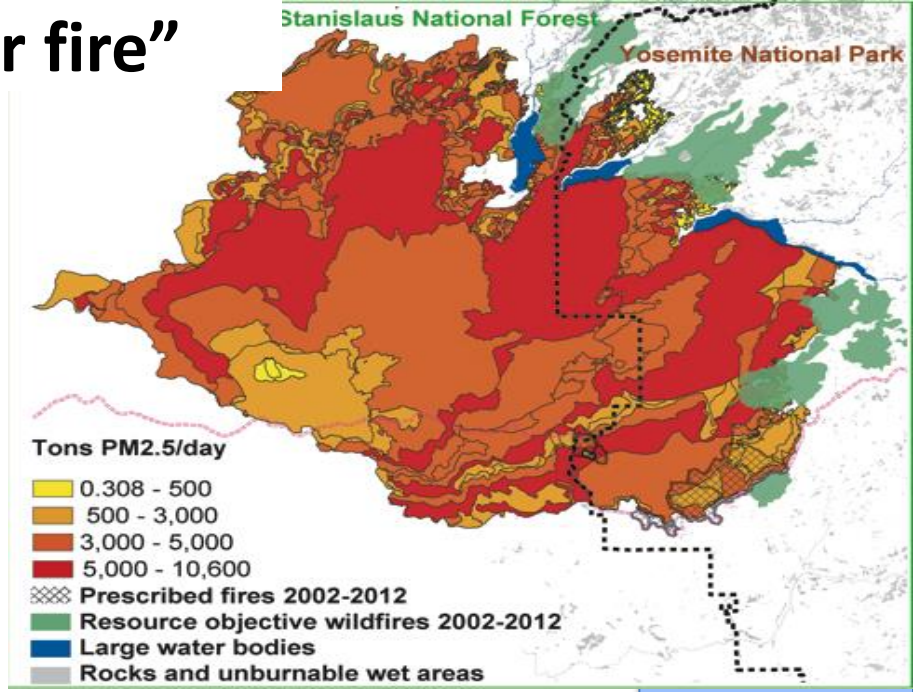
*that threshold is a priori, and subject to change as better data and analysis are brought to bear

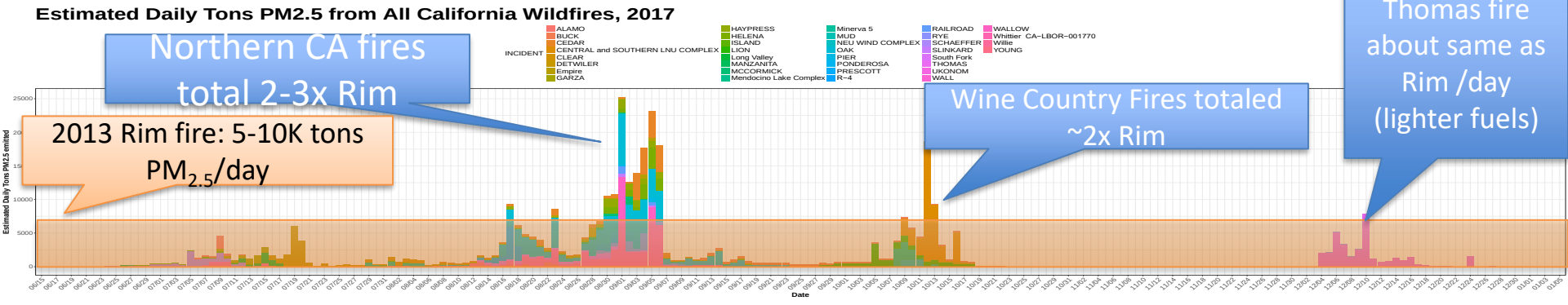
Goals

- Give you to the tools to work in terms of emissions rather than acres
- Outline how the airfire playground model runs and monitoring results can be used to create better, more timely and specific advice for avoiding smoke
- Understand the air monitoring tools, and how that can be the core platform for consistent messaging across jurisdictions

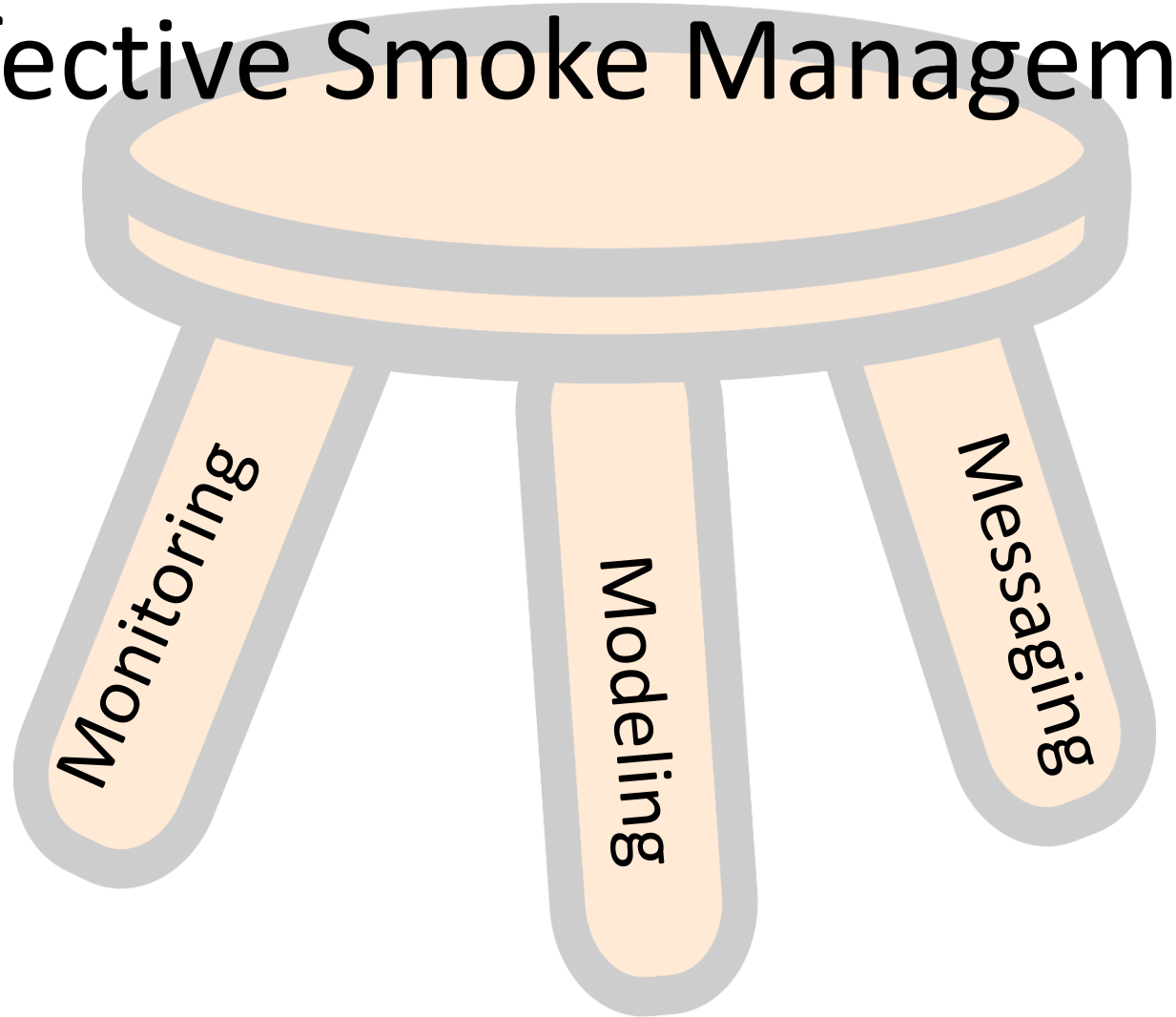
Why? Good fire is often “slower fire”

- Megafire packs thousands, even tens of thousands of tons of $PM_{2.5}$ into **<u>single days</u>**;
- Slower fires (i.e., Rx and Wildfire for Resource Objectives) spread the emissions out
- Good/slower fire limits growth of future fires
  - Yosemite worked for decades to build the fuel treatments that could be linked together to help limit the Rim fire’s spread
- **DAILY TONS** (PM2.5) is the starting point for gaging impacts





Effective Smoke Management



EMISSIONS (DAILY TONS)

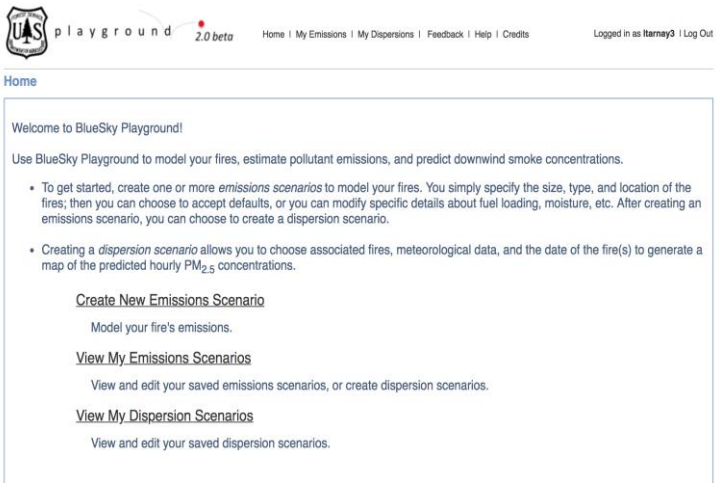
2018 Green Mtn Project

Translating acres to emissions

- "Rule" of thumb
  - Heavy loading (~90-100 tons/acre of biomass) is about ~0.8-1.0 tons PM2.5/acre when burned
  - Light loading (~10 tons or less biomass/acre) is usually < ~0.1 tons PM2.5/acre when burned
  - Acres/day*tons PM2.5/acre => Daily PM2.5
    - PM10 is about 1.17*PM2.5

- Jason is making PFIRS more "emissions" friendly, so that these emissions numbers are created for you, **IF** the project smoke management plan is in that system, and you use it for daily authorizations

- Or you can use the airfire tools: BlueSky Playground



https://tools.airfire.org/

Note that v3 is being implemented, Previous v2 version is not receiving model updates

Playgound V2 (beta) vs V3 (alpha)

https://pgv3.airfire.org/playground/v3/emissionsresults.php?scenario_id=15b2a9bd23b57d

PDF

Report

Report Title	Playground Report: 6/20/2018	Reporter	Leland Tarnay
Fuelbed	44 - Scrub oak chaparral shrubl…	Date	6/20/2018
Latitude	40.7813 degrees	Longitude	-122.1419 degrees
Size		Fire Type	Prescribed

playground 2.0 beta

Home | My Emissions | My Dispersions | Feedback | Help | Credits

Logged in as **ltarnay3** | Log Out

Home » My Emissions » 2018GrnMtn (Broadcast)

Size and Location | Fuels | Moisture | Consumption | Timing | Emissions | Notes

Emissions Model

FEPS

Emissions Results

$PM_{2.5}$	147.86	tons	CH_4	84.37	tons
PM_{10}	174.47	tons	NO_X	21.68	tons
CO	1732.27	tons	VOCs	408.15	tons
CO_2	19381.09	tons	NH_3	28.39	tons
GHGs	23222.56	tons CO_2e	SO_2	12.42	tons
			Heat	998.05	BTU/ft^2

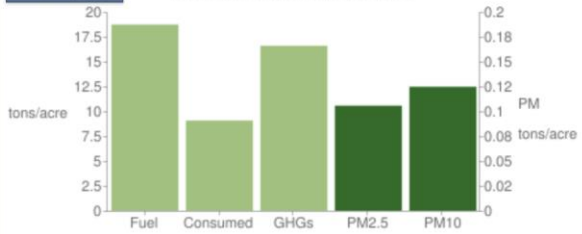
V2 beta (Current)

https://playground.airfire.org/step.php?EmissionsScenarioID=15a8311464b583&page=emissions

Discard Changes | Apply

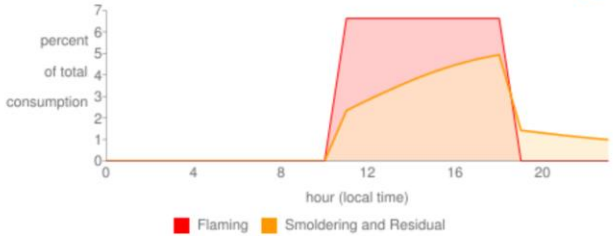
View Totals

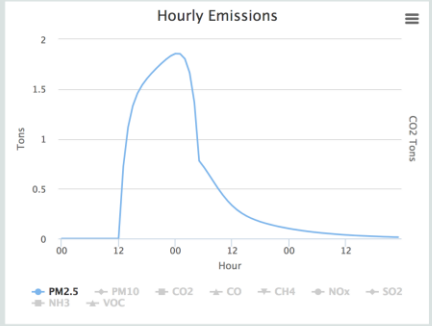
Fuels and Emissions per Acre



Diurnal Profile of % Total Consumption

Day 1





Emissions	tons
$PM_{2.5}$	32.51
PM_{10}	38.36
CO	340.74
CO_2	7707.98
GHGs	8473.48
CH_4	16.99
NO_x	16.45
VOC	80.57
NH_3	6.91
SO_2	2.44

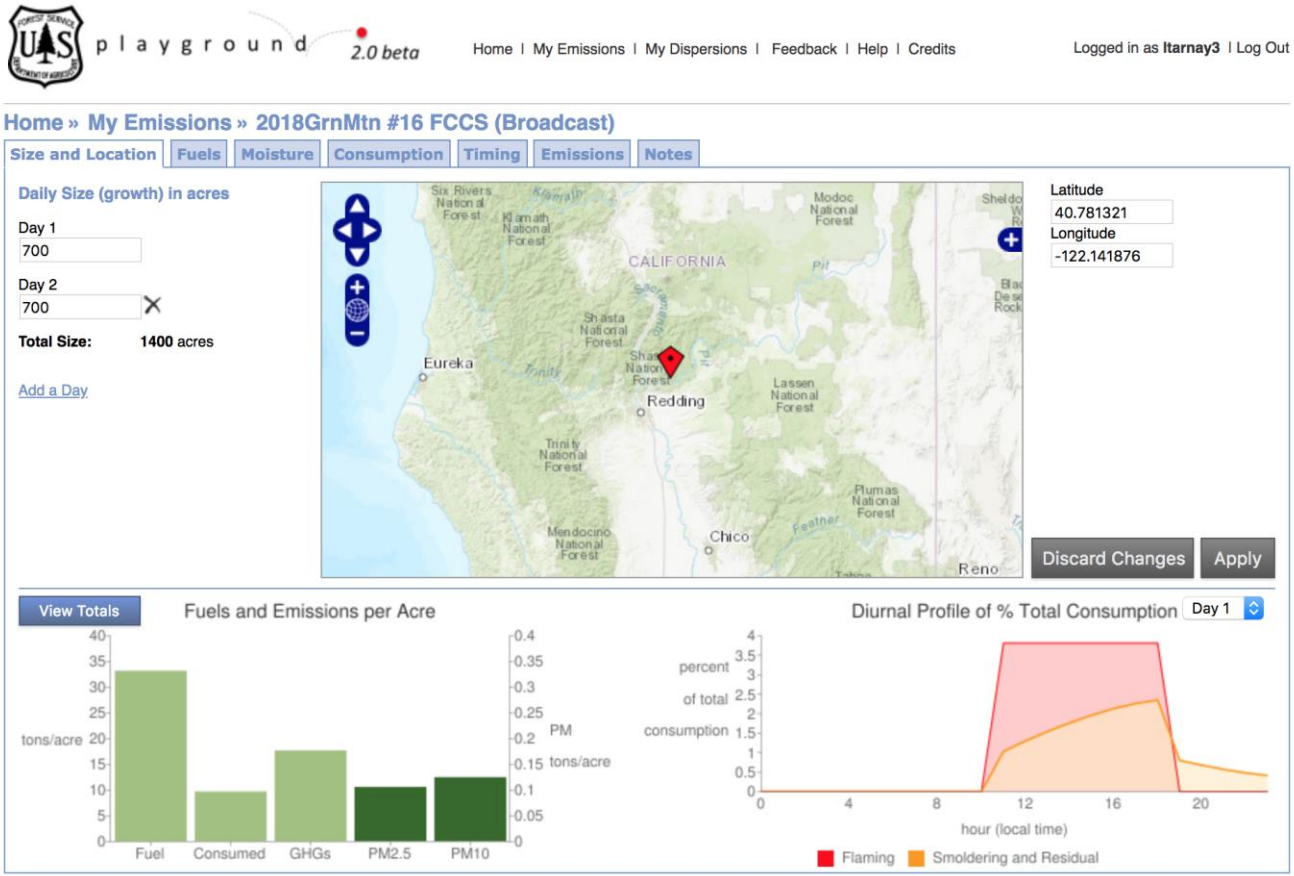
V3 alpha (may replace V2 this year)

Run VSMOKE | Run HYSPLIT

Version 3.0.1

Emission Scenario:

- 1400 acres over 2 days
- 148 tons PM2.5 tota divided ove those days



https://playground.airfire.org/share.php?scenarioType=emissions&scenarioID=15b3248e2a0bf4

Garbage in; Garbage out issues: Fuel Load

- Emissions can vary by factor of 10; defaults often not representative
  - Check with your fuels lead to ensure you know what fuels are likely representative

Here's what you get when you pick from the map (FCCS#16)

Home » My Emissions » 2018GrnMtn #16 FCCS (Broadcast)

Size and Location | Fuels | Moisture | Consumption | Timing | Emissions | Notes

Use Fuels From
- (•) FCCS Fuelbed #16 From Map
- ( ) FCCS Fuelbeds
- ( ) LANDFIRE Fuel Loading Models
- ( ) Custom Fuel Loading

Fuel Loading Results

1-hr	0.3	tons/acre	Canopy	8.33	tons/acre
10-hr	1.4	tons/acre	Shrubs	2.43	tons/acre
100-hr	1.8	tons/acre	Grasses	0.14	tons/acre
1,000-hr	0.8	tons/acre	Litter	0.06	tons/acre
10,000-hr	2.5	tons/acre	Rotten	3.2	tons/acre
>10,000-hr	0	tons/acre	**Total Above Ground**	**14.16**	**tons/acre**
Total Sound Woody	**6.80**	**tons/acre**			
Duff Depth	1	inches	**Total Fuel Loading**	**33.08**	**tons/acre**

https://playground.airfire.org/share.php?scenarioType=emissions&scenarioID=15b3248e2a0bf4

Here's what you get when you pick Doug/White Fir(FCCS #45)

Size and Location | Fuels | Moisture | Consumption | Timing | Emissions | Notes

Use Fuels From
- ( ) FCCS Fuelbed #16 From Map
- (•) FCCS Fuelbeds
- ( ) LANDFIRE Fuel Loading Models
- ( ) Custom Fuel Loading

FCCS Fuelbed: 54 Douglas-fir - White fir

Fuel Loading Results

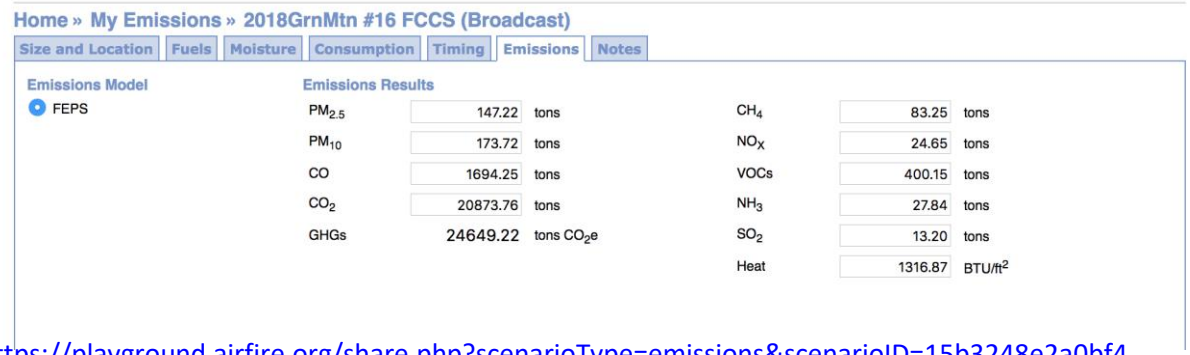
1-hr	0.3	tons/acre	Canopy	25.75	tons/acre
10-hr	2.4	tons/acre	Shrubs	0.1	tons/acre
100-hr	4.9	tons/acre	Grasses	0.08	tons/acre
1,000-hr	0.5	tons/acre	Litter	0.03	tons/acre
10,000-hr	3	tons/acre	Rotten	8	tons/acre
>10,000-hr	4	tons/acre	**Total Above Ground**	**33.96**	**tons/acre**
Total Sound Woody	**15.10**	**tons/acre**			
Duff Depth	2	inches	**Total Fuel Loading**	**73.30**	**tons/acre**

https://playground.airfire.org/share.php?scenarioType=emissions&scenarioID=15b3246ac81c48

Garbage in; Garbage out issues: Emissions

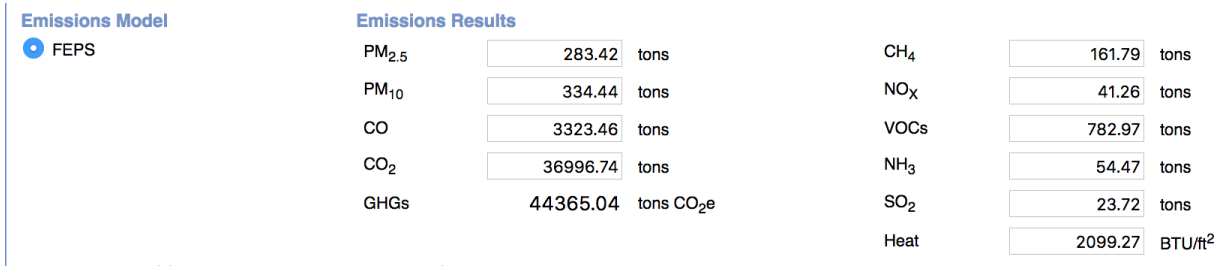
- Emissions can vary by factor of 10; defaults often not representative
  - Check with your fuels lead to ensure you know what fuels are likely representative

Here's what you get when you pick #16 from the map
(147 tons PM2.5)



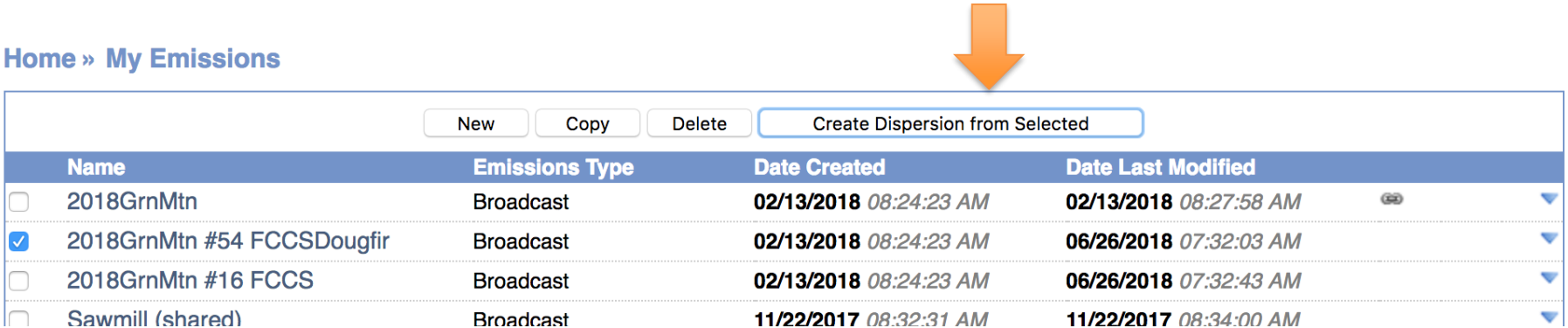
https://playground.airfire.org/share.php?scenarioType=emissions&scenarioID=15b3248e2a0bf4

Here's what you get when you pick a heavy Fuel load (283 tons PM2.5 #54 DougFir)



https://playground.airfire.org/share.php?scenarioType=emissions&scenarioID=15b3246ac81c48

EMISSIONS → DISPERSION SCENARIOS



DISPERSION SCENARIOS

New Dispersion

1 or more Data Sources have been disabled due to selected Emissions being located outside of their domain.

Name

Meteorology Data Source (HYSPLIT)

- (•) CA/NV 2-km
- ( ) Lake States 4-km WRF
- ( ) National 12-km
- ( ) Pacific Northwest 4-km WRF (9/1/2011 - present)

Simple Dispersion/Meteorology

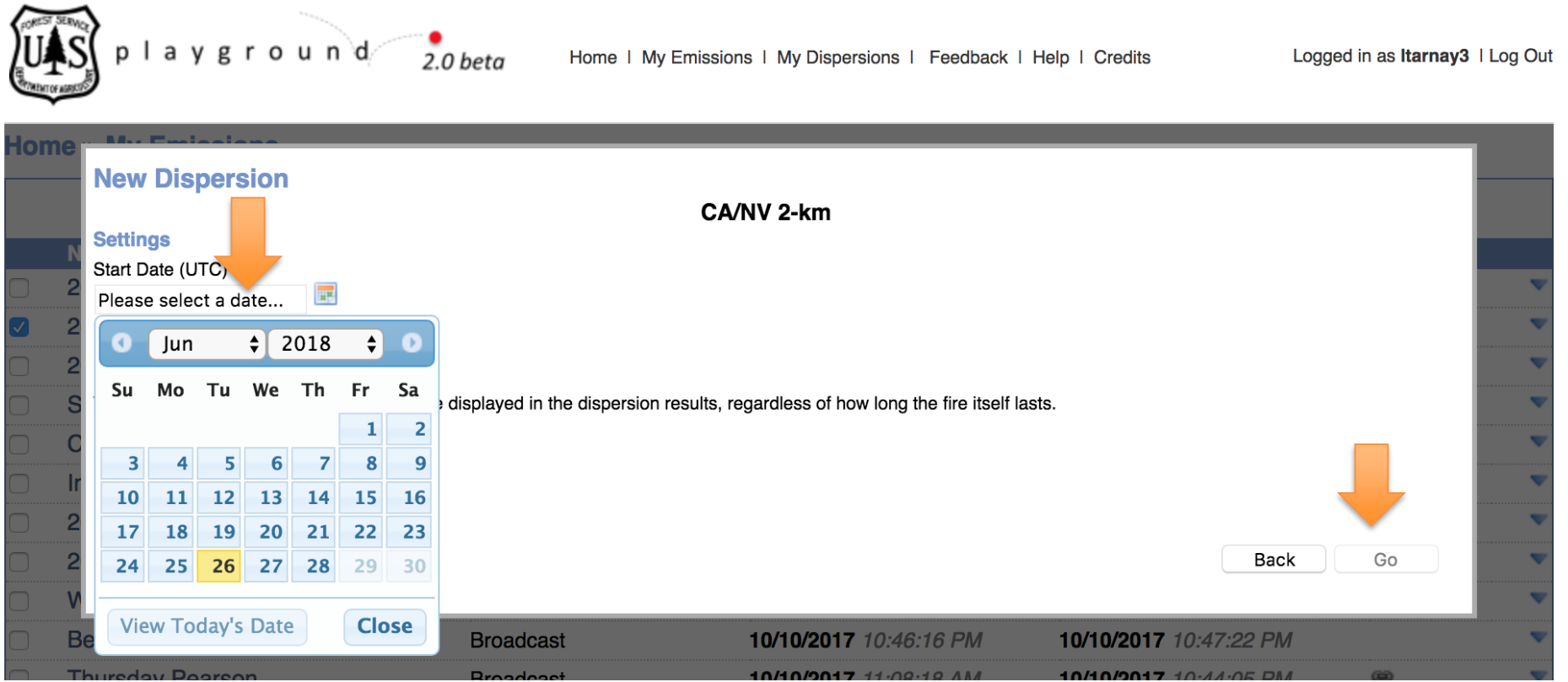
- ( ) VSMOKE

Emissions Scenarios Selected

2018GrnMtn #54 FCCSDougfir

Cancel Next

DISPERSION SCENARIOS



DISPERSION SCENARIOS

Home » My Dispersions

Copy Delete

	Name	Dispersion Model	Date Created	Date Last Modified
☐	(Running...) 2018GrnMtn #16 FCCS	HYSPLIT - CANV-2km	**06/26/2018** *07:44:06 AM*	**06/26/2018** *07:44:06 AM*
☐	(Running...) 2018GrnMtn #54 FCCSDougfir	HYSPLIT - CANV-2km	**06/26/2018** *07:41:49 AM*	**06/26/2018** *07:41:49 AM*
☐	iasc example	HYSPLIT - CANV-2km	**06/25/2018** *09:24:33 AM*	**06/25/2018** *09:24:33 AM*

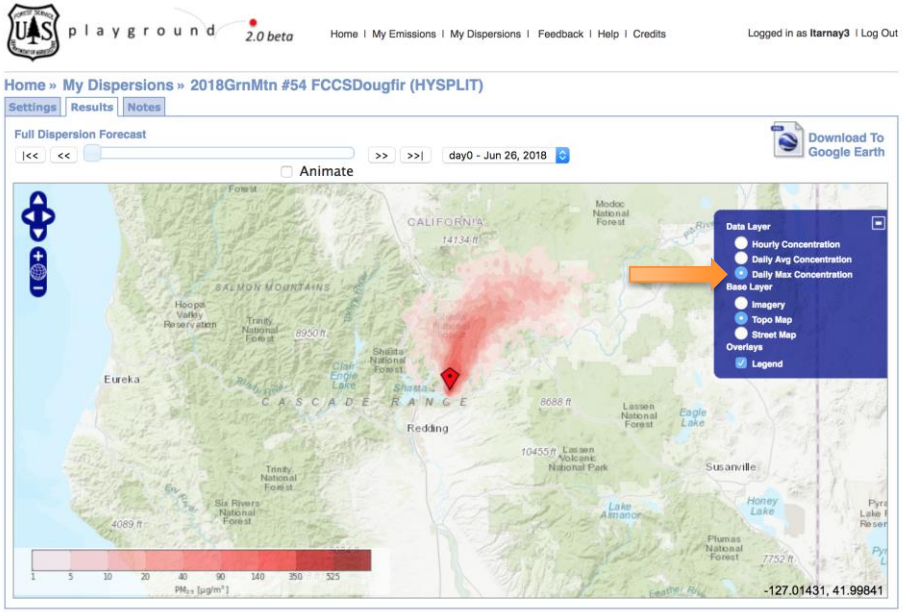
You can share these links as soon as you start the run

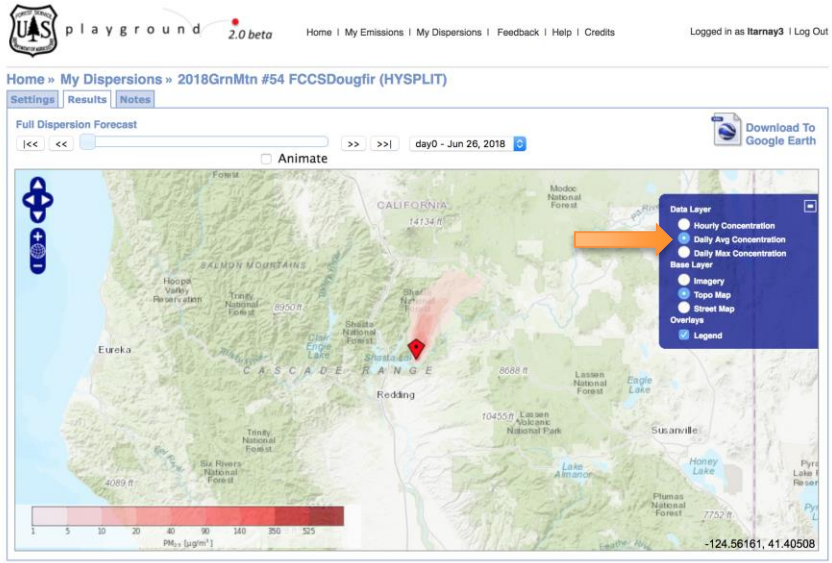
#54 https://playground.airfire.org/share.php?scenarioType=dispersion&scenarioID=15b3250ade6b4b

#16 https://playground.airfire.org/share.php?scenarioType=dispersion&scenarioID=15b32513681493

DISPERSION INTERP: Daily Max vs. Average graphs

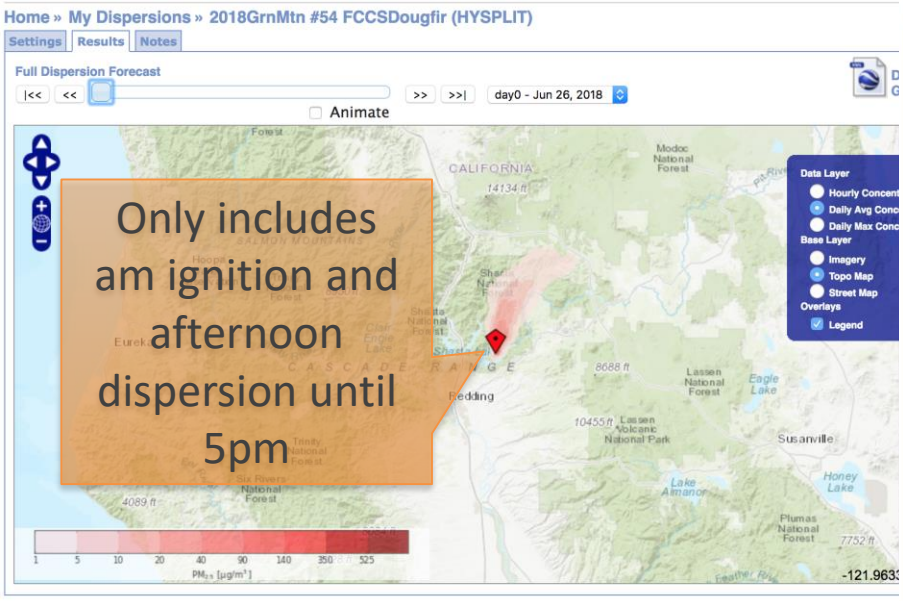
- The Daily max does not depict a real plume, but the max that happens over the 24 hr period for each pixel. Those Maximum values DO NOT (necessarily) COINCIDE IN TIME, even if they coincide in space
  - Reallly should be called the hourly max
- Since the endpoint is usually some idea of how the AQI tomorrow will be different than the AQI today or yesterday, best recommend using 24 hr average to compare days
  - For PDT, This is a 5pm to 5pm 24 hr average, not a midnight 24 hr average, like you'll get from the monitoring site

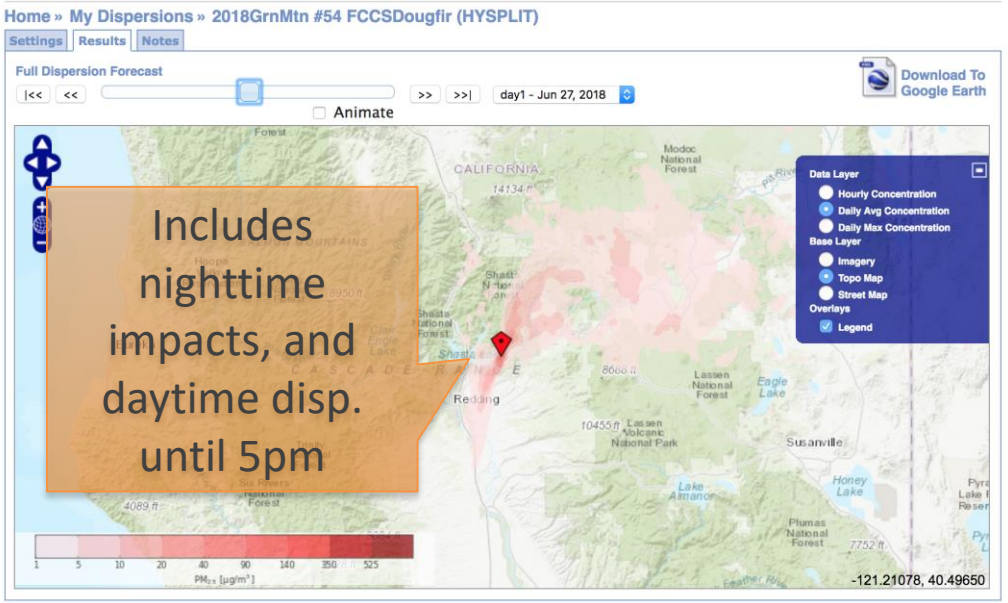




DISPERSION INTERP: Issues with Comparing 24 hr periods

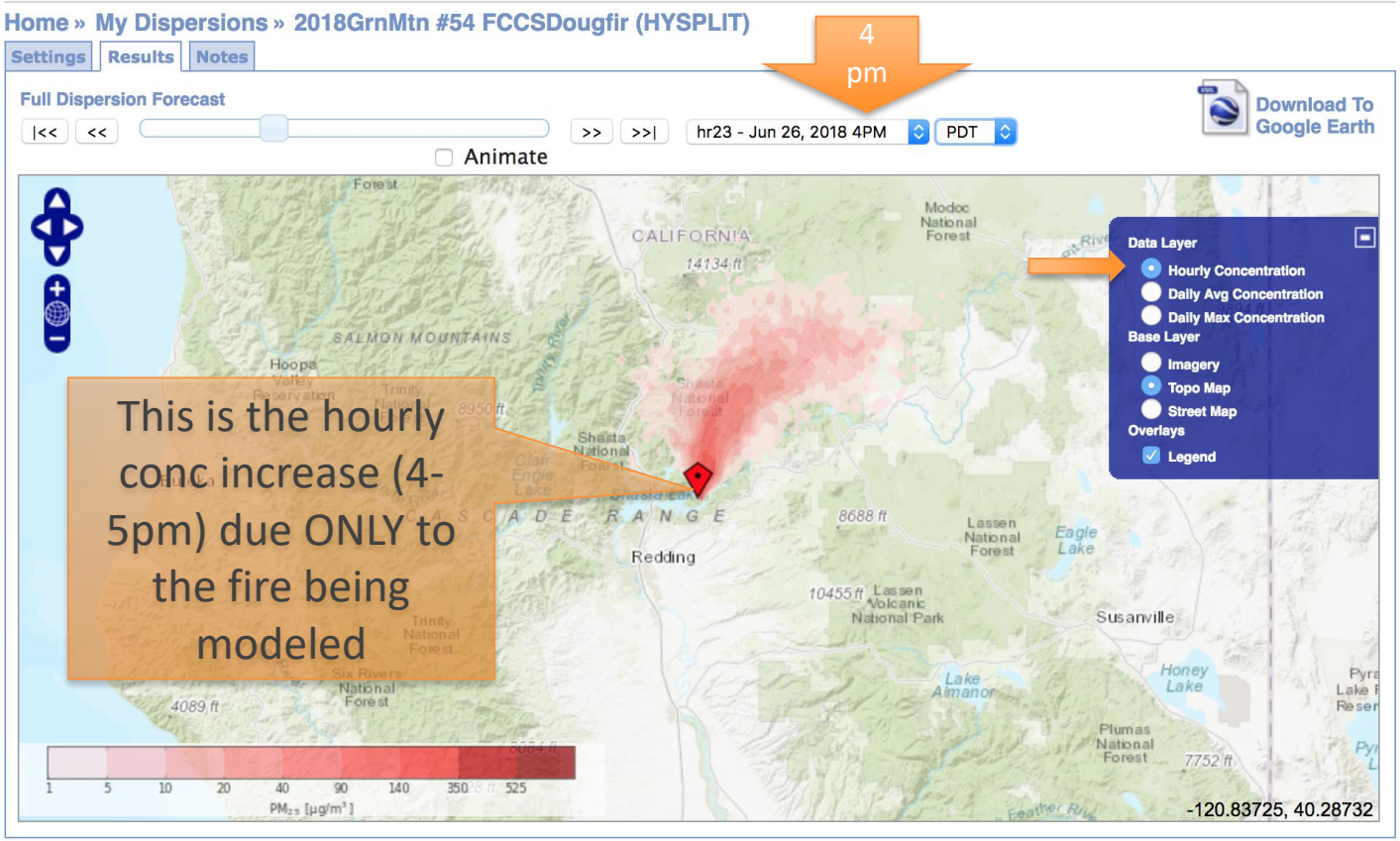
- For comparing one day (i.e., today) with another day (i.e., tomorrow), best not to look at hourly, but at 24 hr averages
- Unfortunately, that's not a midnight to midnight local time average in the model, but a 5pm to 5pm average (5pm is midnight GMT, during daylight savings in CA)
- Captures the general pattern of impact spatially…nothing likely to add more than a few 10s of ug/m^3 to baseline concentrations





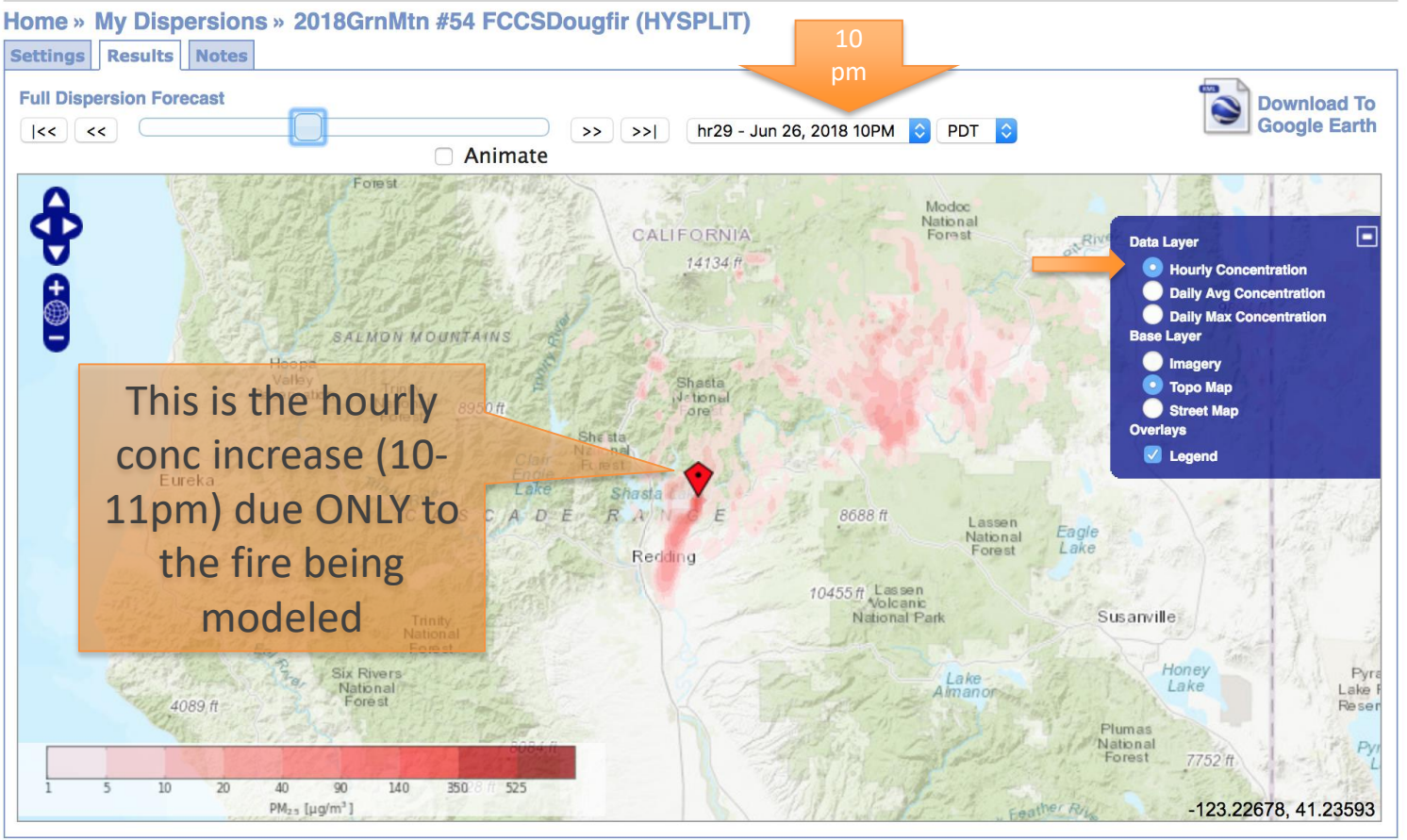
DISPERSION INTERP: Using Hourlies to understand timing of impacts (4pm PDT, Day 1)

- I like to establish a consistent set of times: ~10 pm, 7 am, 11am, 4 pm
- Don't take that conc value literally, but rather relatively
- Doesn't know about other fires smoke, or about carry-over smoke from previous days



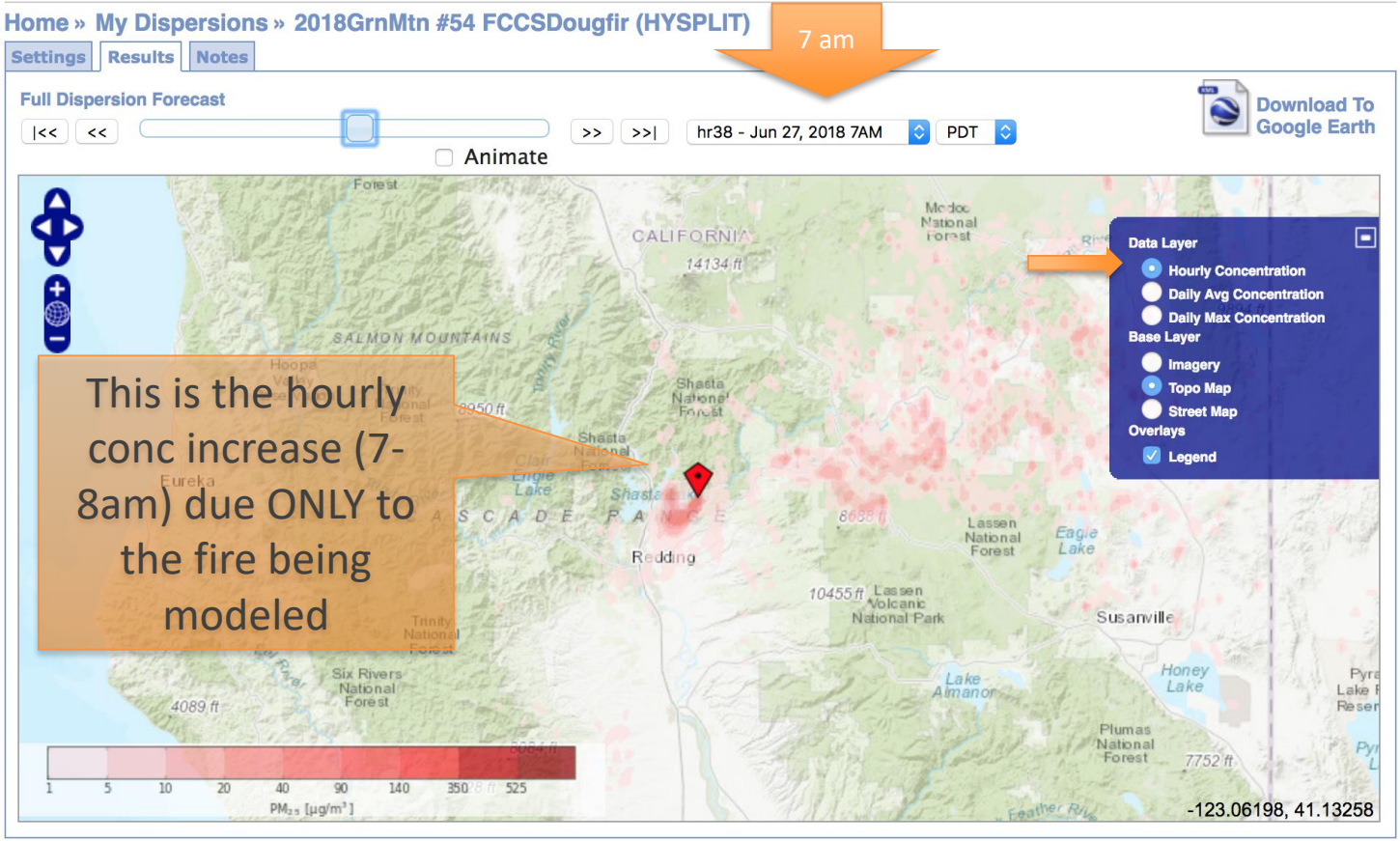
DISPERSION INTERP: Using Hourlies to understand timing of impacts (10pm PDT, Day1)

- I like to establish a consistent set of times: ~10 pm, 7 am, 11am, 4 pm



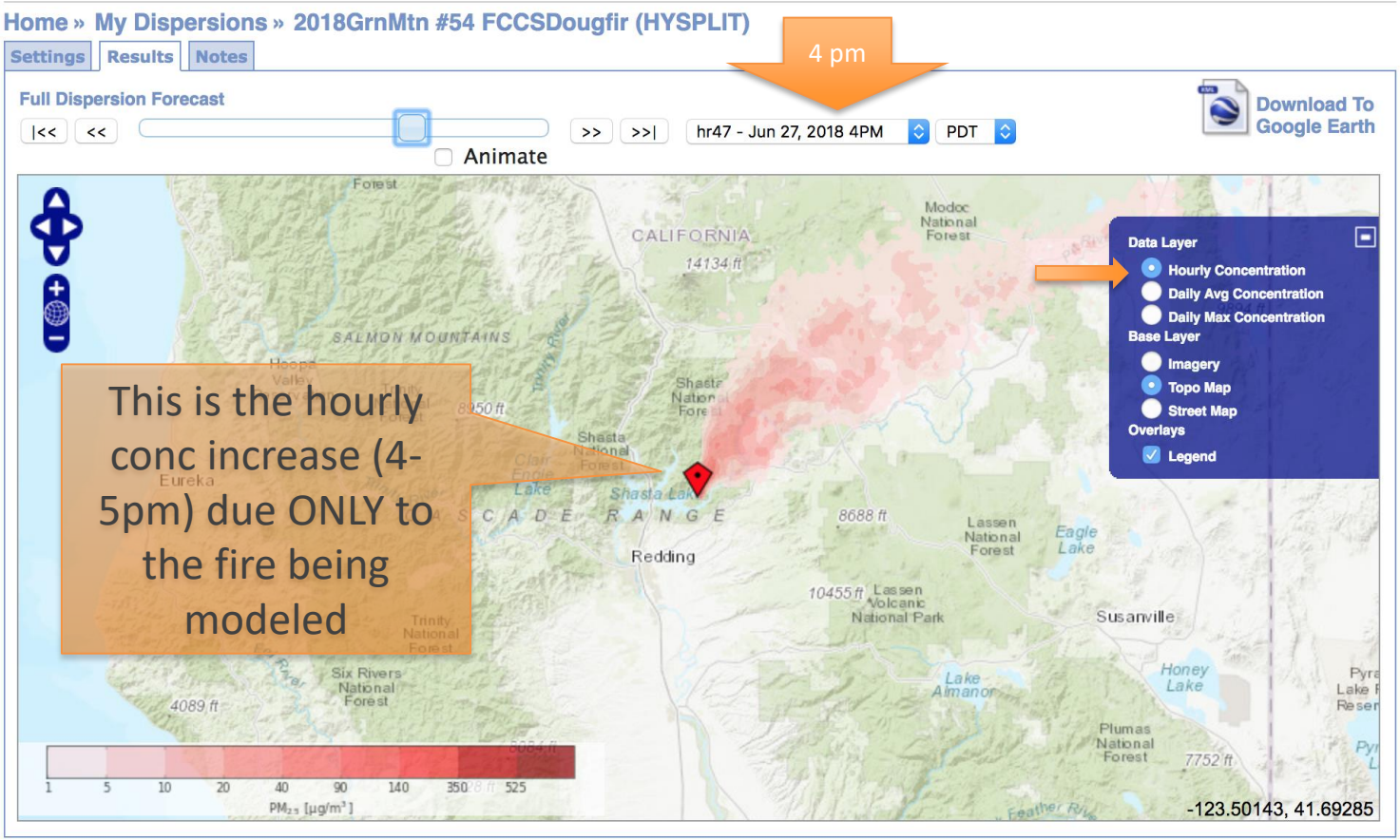
DISPERSION INTERP: Using Hourlies to understand timing of impacts (7am PDT, Day2)

- I like to establish a consistent set of times: ~10 pm, 7 am, 11am, 4 pm



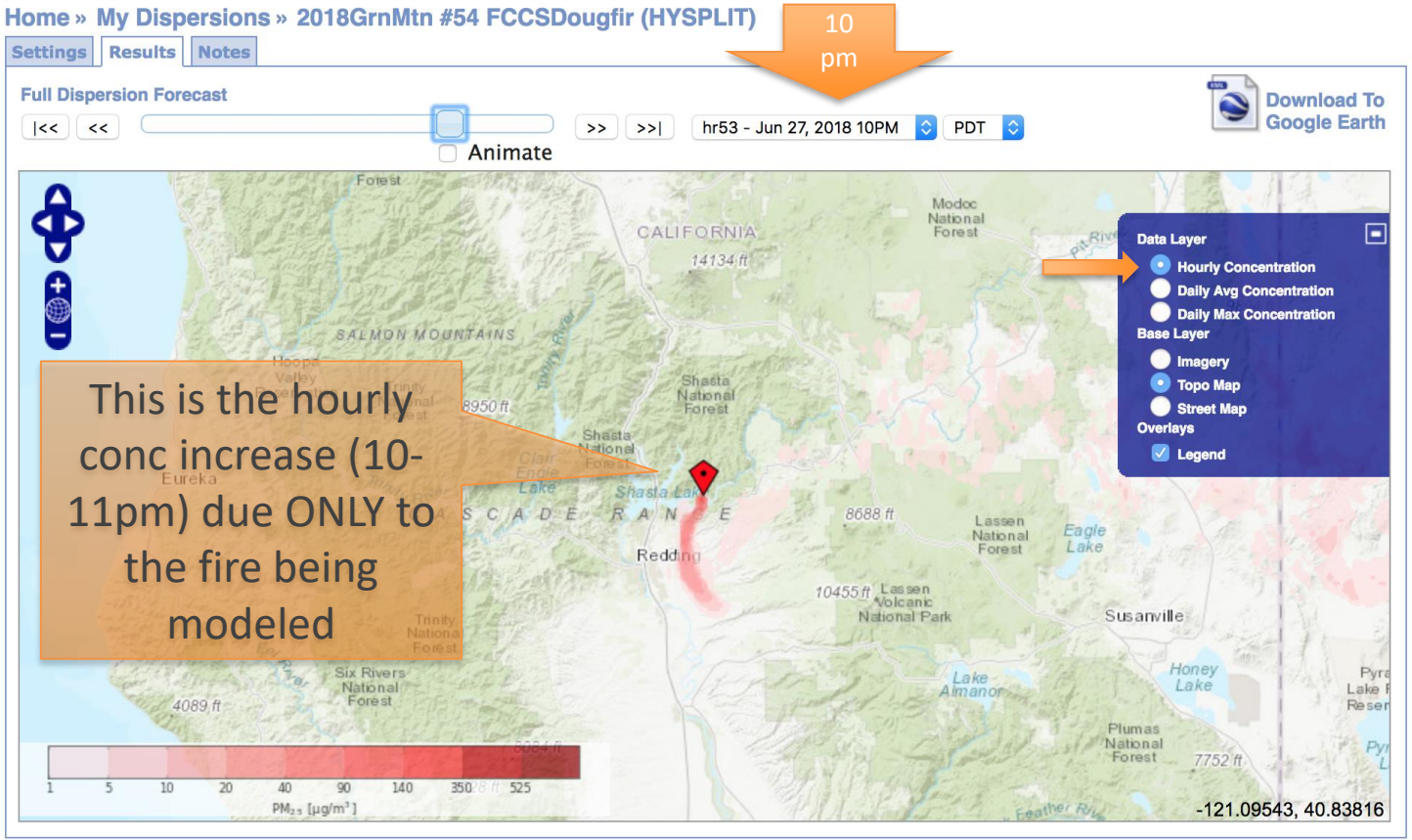
DISPERSION INTERP: Using Hourlies to understand timing of impacts (4pm PDT, Day 2)

- I like to establish a consistent set of times: ~10 pm, 7 am, 11am, 4 pm



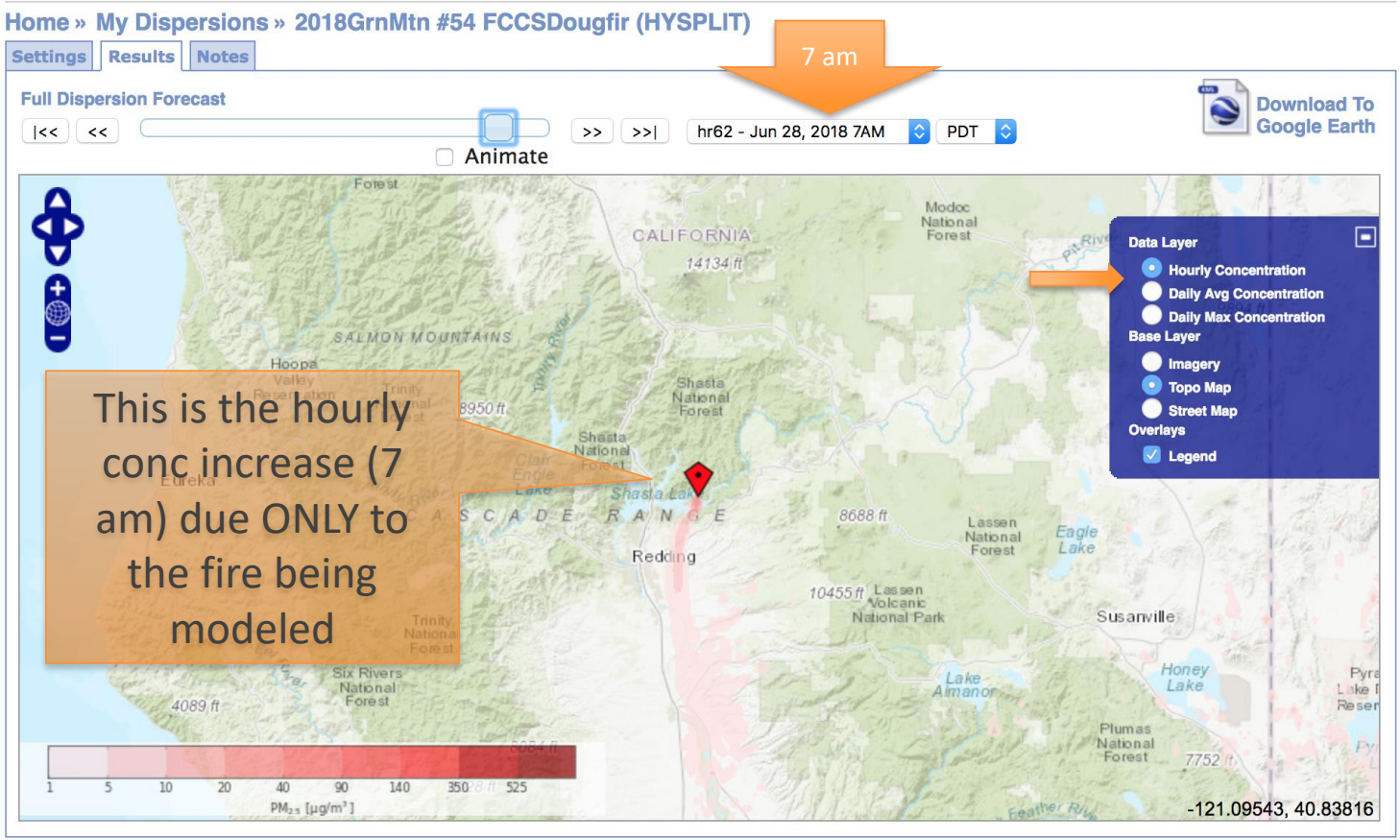
DISPERSION INTERP: Using Hourlies to understand timing of impacts (10pm PDT, Day 2)

- I like to establish a consistent set of times: ~10 pm, 7 am, 11am, 4 pm
- Note the downcanyon air pushing the plume into the valley…we would let people there in redding know that there would be some TRANSIENT SMOKE overnight



DISPERSION INTERP: Using Hourlies to understand timing of impacts (7 am PDT, Day 3)

- I like to establish a consistent set of times: ~10 pm, 7 am, 11am, 4 pm
- Note the down canyon air pushing the plume into the valley…we would let people there in redding know that there would be some TRANSIENT SMOKE overnight, but that it would disappate as/before the sun rose



Exercises

- Try doing this same process for the lighter fuel loads
  - https://playground.airfire.org/share.php?scenarioType=dispersion&scenarioID=15b32513681493
- If you are really fast, try it for double the acres
  - https://playground.airfire.org/share.php?scenarioType=dispersion&scenarioID=15b327b6018c45
  - Does doubling acres (emissions) double impacts?
    - (no)

Would you give a “go” to this burn?

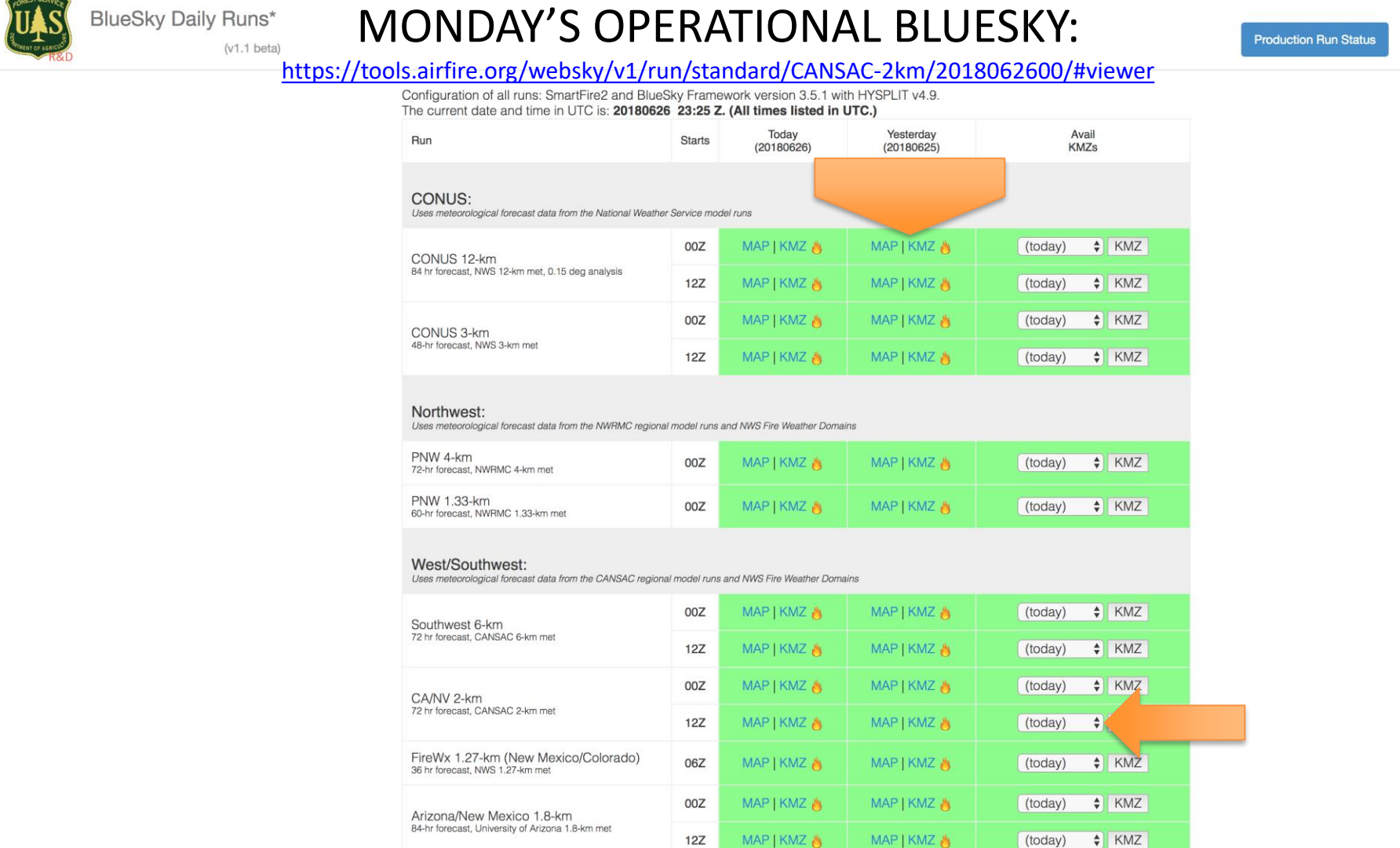
- Would fuel load matter?
- Does doubling acres double impacts?
- Transient nighttime impacts
- No heavy impacts on 24 hr Daily AQI
- Where would you monitor?

It’s a Yardstick, not the answer

- Bluesky doesn’t know any more than you tell it about emissions
- Doesn’t know about other sources of PM2.5
- Doesn’t carry over smoke from one run to the next
- Doesn’t do great with small scale terrain (2km is the max resolution)
  - Tends to overestimate vertical mixing from mtn sources to valley receptors
- Operational run uses map based fuels from FCCS (like from our Rx scenarios), along with acres based on MODIS pixels.
  - This is very coarse resolution, and the center of each MODIS pixel count drives the choice of fuels (and can misrepresent each respective pixel

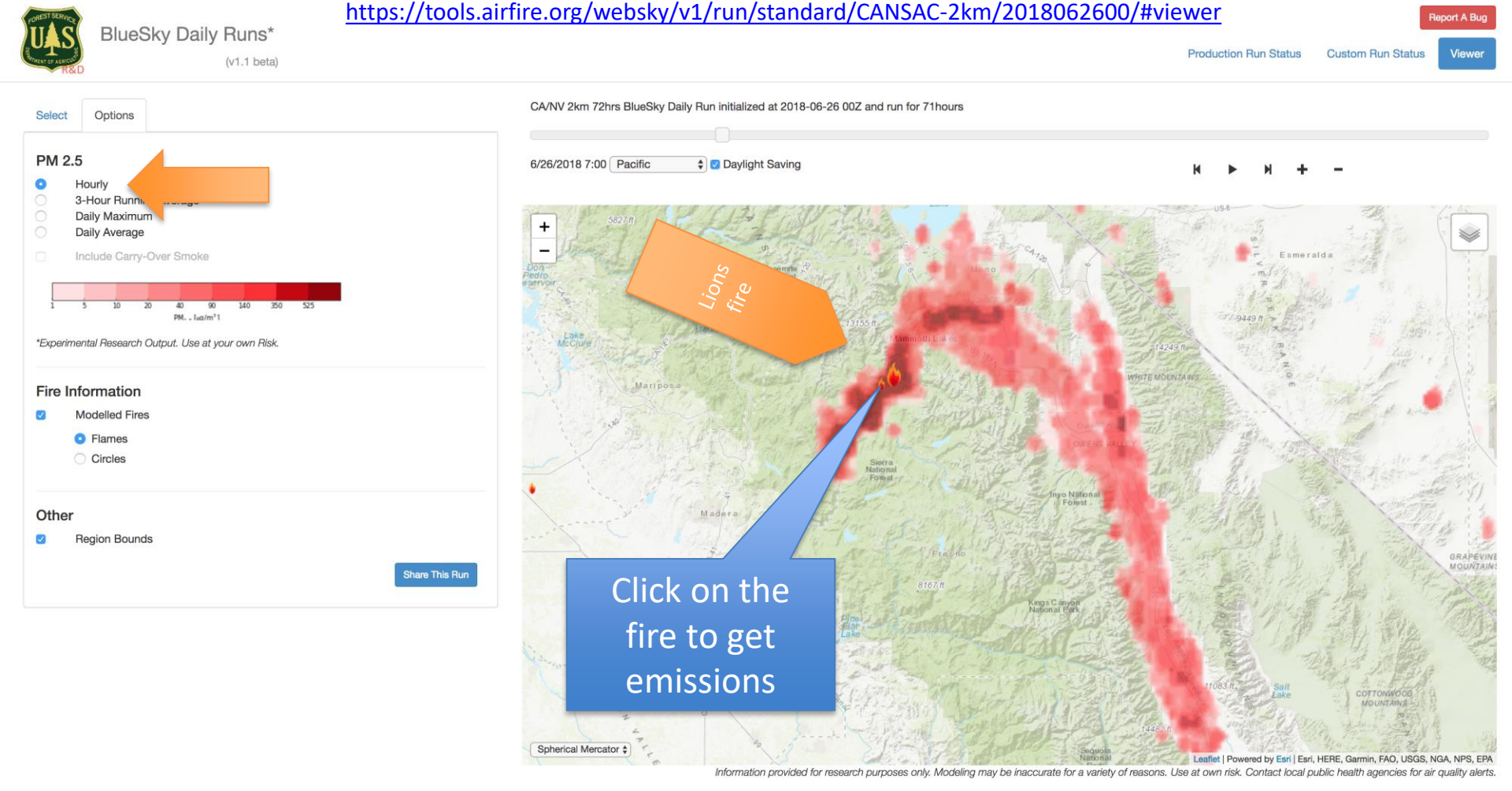
MONDAY'S OPERATIONAL BLUESKY:

https://tools.airfire.org/websky/v1/run/standard/CANSAC-2km/2018062600/#viewer



MONDAY'S OPERATIONAL BLUESKY:

https://tools.airfire.org/websky/v1/run/standard/CANSAC-2km/2018062600/#viewer



Lions Operational emissions in context

Dead and downed high-elevation red fir, usually this would be an overestimate, but likely accurate or low for the fuels burned on 6/24

Fire Information

Satellite Hotspot Detection(s)* in Madera County, California

Location: 37.566, -119.139

Anticipated Type: WF

Modeled Growth (based on persistence)

Monday, Jun 25, 2018: 2612 acres
Tuesday, Jun 26, 2018: 2612 acres
Wednesday, Jun 27, 2018: 2612 acres
Thursday, Jun 28, 2018: 2612 acres

FCCS Fuelbeds

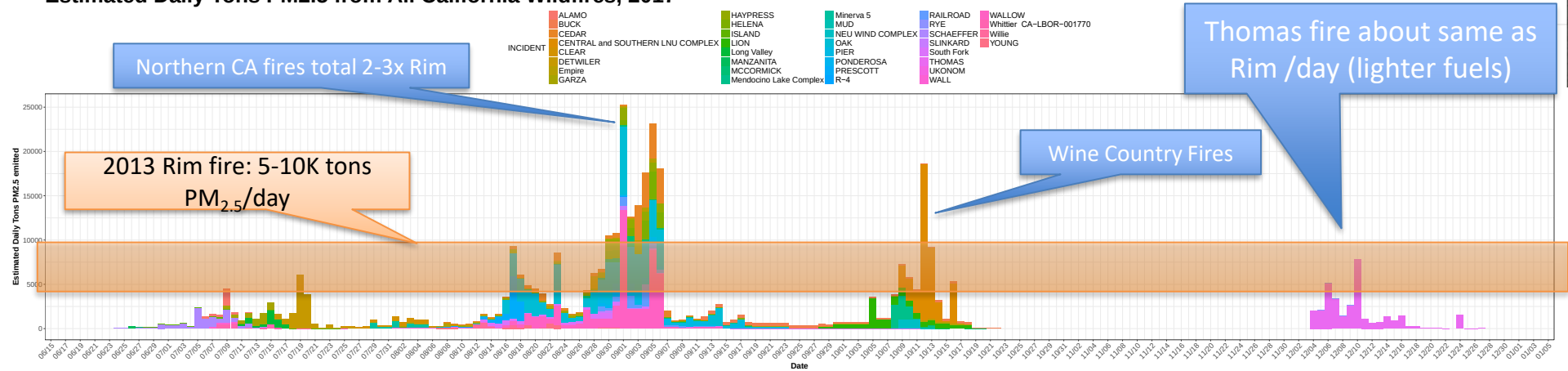
#17 - 2612 acres - Red fir forest

Daily Emissions Modeled

PM2.5: 3029.52 tons
PM10: 3574.83 tons

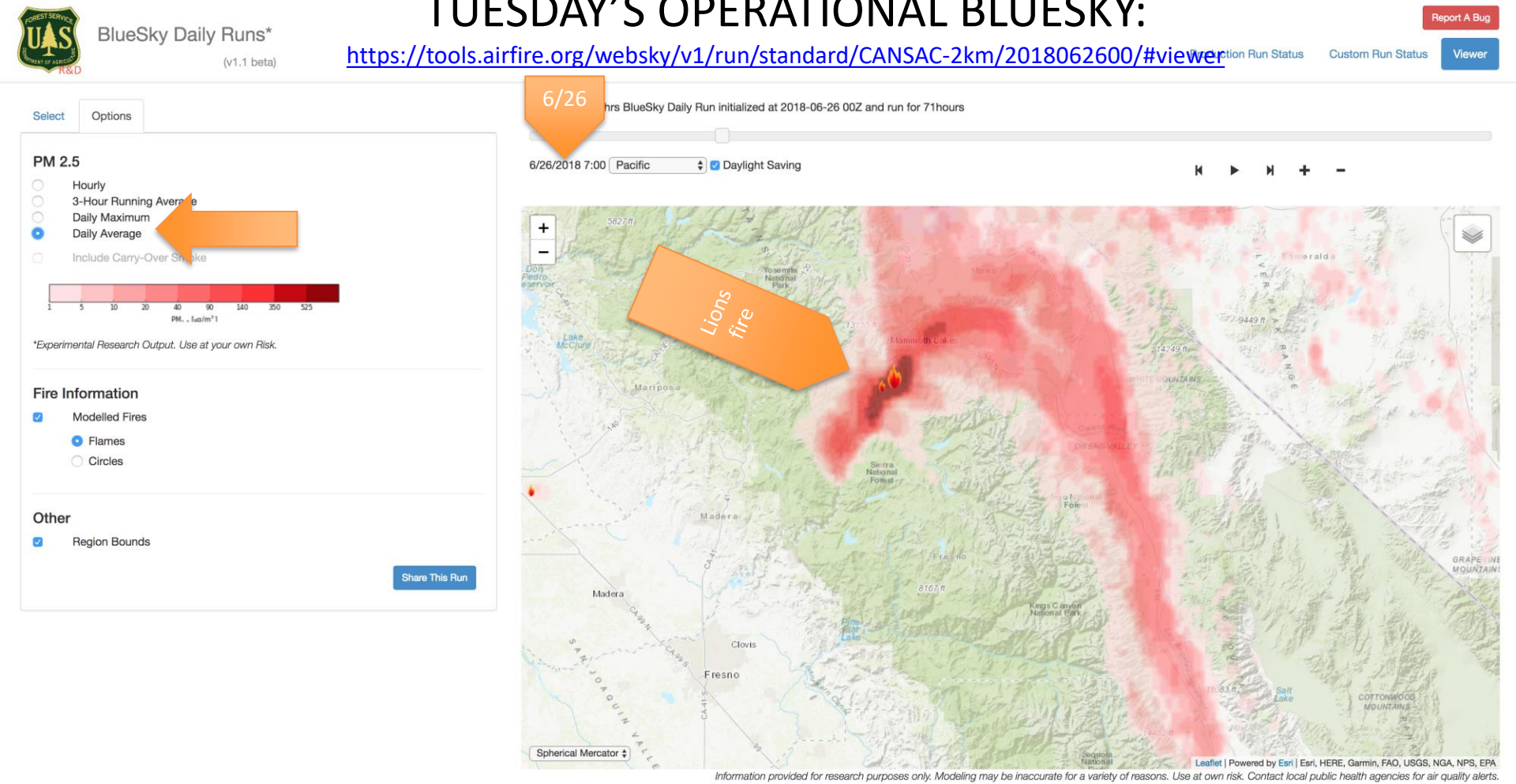
**Modeled fire information is derived in part from satellite hotspot detections and other sources that can contain false detections and other errors. Modeled fire information is provided here only to show what information was used within the smoke model run.*

Estimated Daily Tons PM2.5 from All California Wildfires, 2017



TUESDAY'S OPERATIONAL BLUESKY:

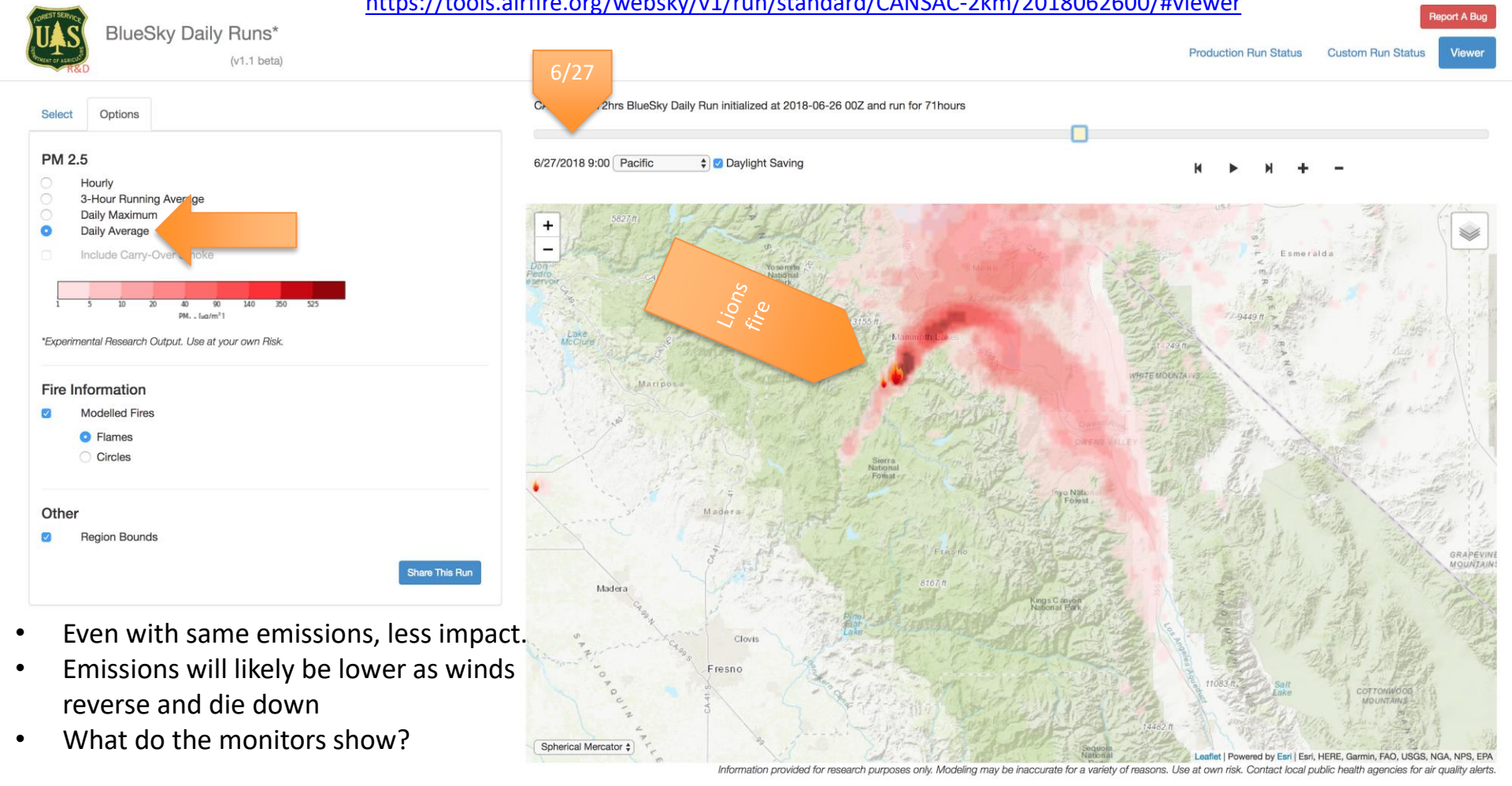
https://tools.airfire.org/websky/v1/run/standard/CANSAC-2km/2018062600/#viewer



Information provided for research purposes only. Modeling may be inaccurate for a variety of reasons. Use at own risk. Contact local public health agencies for air quality alerts.

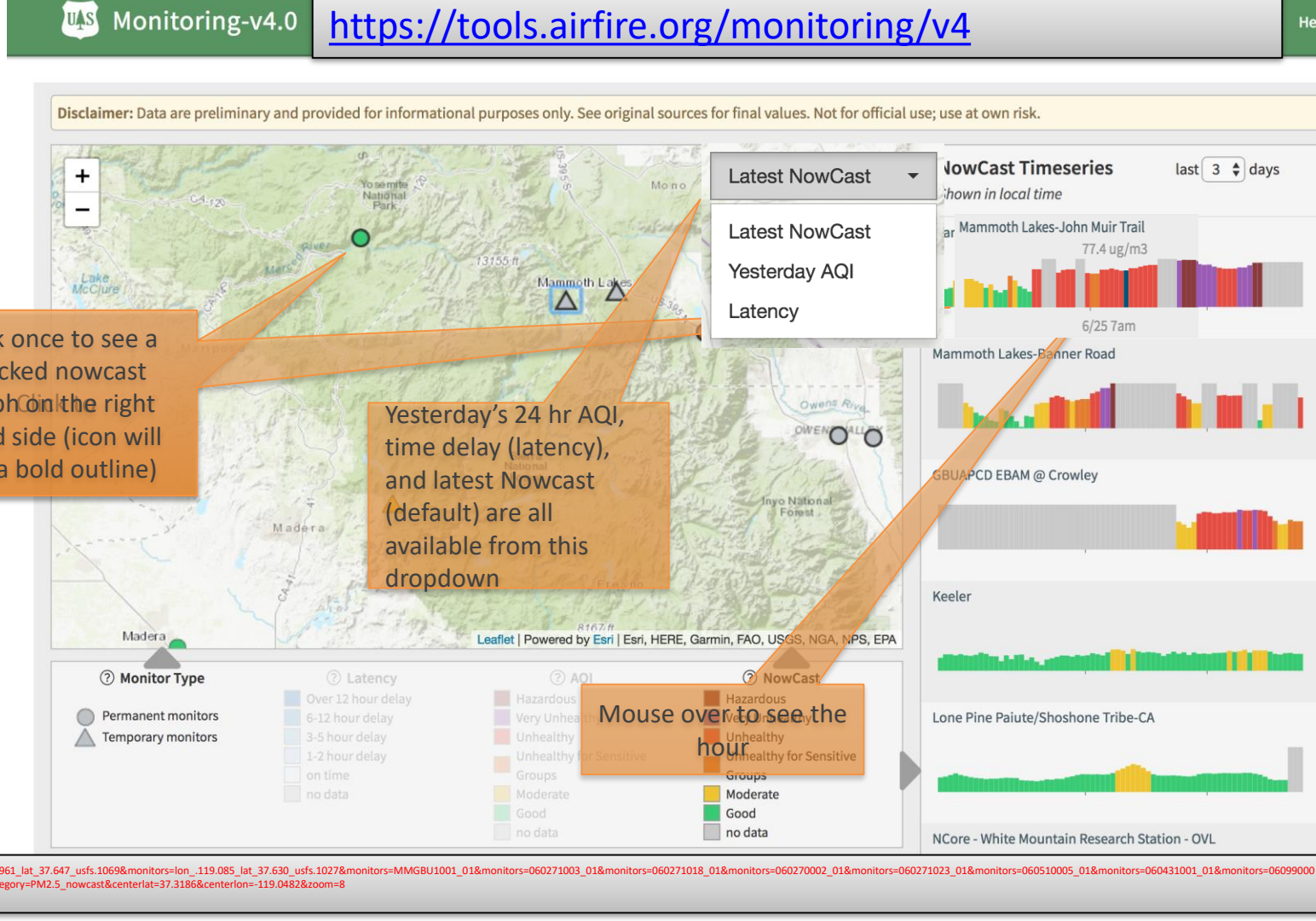
Will Wednesday be worse (assuming persistent emissions)?

https://tools.airfire.org/websky/v1/run/standard/CANSAC-2km/2018062600/#viewer



- Even with same emissions, less impact.
- Emissions will likely be lower as winds reverse and die down
- What do the monitors show?

Monitoring “v4” site (top)



Click once to see a stacked nowcast graph on the right hand side (icon will get a bold outline)

Yesterday’s 24 hr AQI, time delay (latency), and latest Nowcast (default) are all available from this dropdown

Mouse over to see the hour

You can send this URL to anyone (stable), and they can bookmark and refresh to get the latest for the set of selected monitoring sites

https://tools.airfire.org/monitoring/v4/#!/?monitors=lon_-118.961_lat_37.647_usfs.1069&monitors=lon_-119.085_lat_37.630_usfs.1027&monitors=MMGBU1001_01&monitors=060271003_01&monitors=060271018_01&monitors=060270002_01&monitors=060271023_01&monitors=060510005_01&monitors=060431001_01&monitors=060990006_01&monitors=060470003_01&monitors=060192009_01&category=PM2.5_nowcast&centerlat=37.3186&centerlon=-119.0482&zoom=8

Monitoring “v4” site 2 (scroll down)

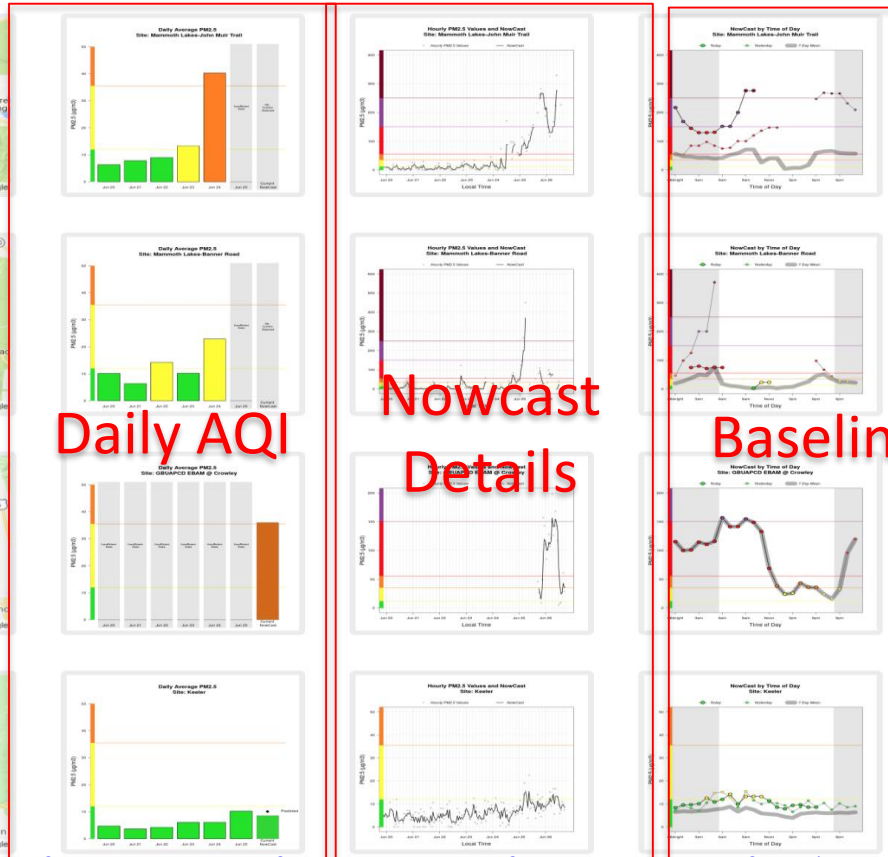
Selected Monitors: *12 monitors from 1 timezones.* Data Report CSV File

Mammoth Lakes-John Muir Trail
Monitor ID: lon_.119.085_lat_37.630_usfs.1027
Soure: AIRSIS
Latest NowCast $PM_{2.5}$: *no data*
Last Updated 2018-06-26 20:00:00 UTC
Timezone: America/Los_Angeles
QA/QC: Report
Show in Simple Interface

Mammoth Lakes-Banner Road
Monitor ID: lon_.118.961_lat_37.647_usfs.1069
Soure: AIRSIS
Latest NowCast $PM_{2.5}$: *no data*
Last Updated 2018-06-27 00:00:00 UTC
Timezone: America/Los_Angeles
QA/QC: Report
Show in Simple Interface

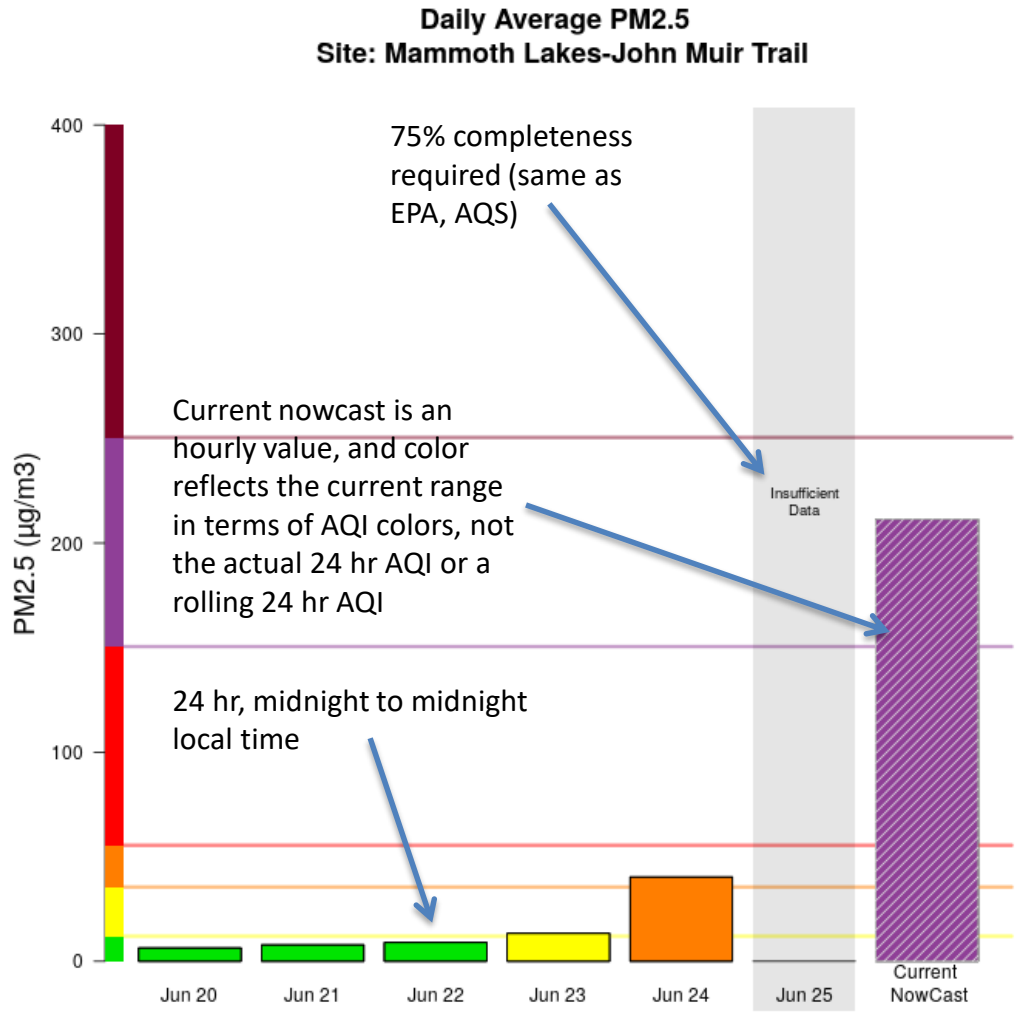
GBUAPCD EBAM @ Crowley
Monitor ID: MMGBU1001_01
Soure: AirNow
Latest NowCast $PM_{2.5}$: **36.1** µg/m^3
Last Updated 2018-06-27 00:00:00 UTC
Timezone: America/Los_Angeles
QA/QC: by AirNow
Show in Simple Interface

Keeler
Monitor ID: 060271003_01
Soure: AirNow
Latest NowCast $PM_{2.5}$: **8.6** µg/m^3
Last Updated 2018-06-27 00:00:00 UTC
Timezone: America/Los_Angeles
QA/QC: by AirNow
Show in Simple Interface



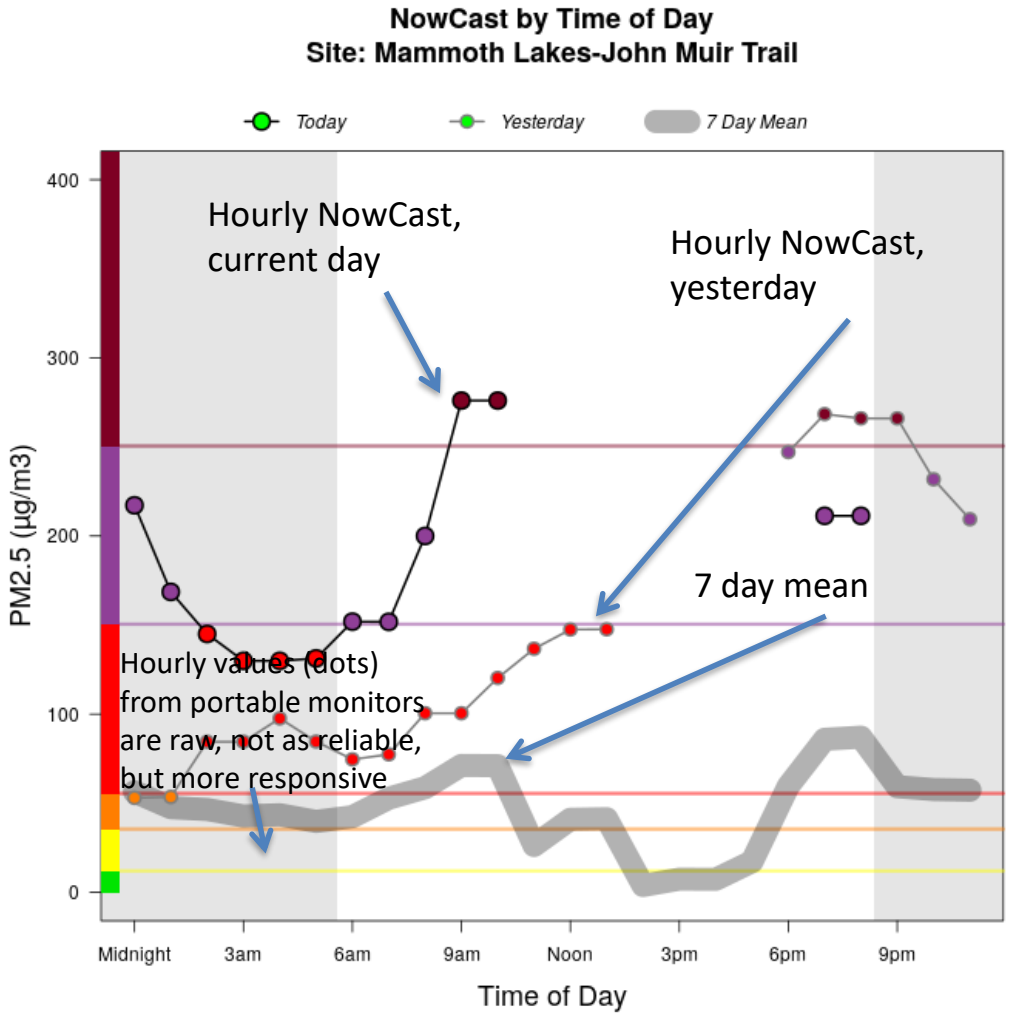
https://tools.airfire.org/monitoring/v4#!/?monitors=060410001_01&monitors=060950004_01&monitors=060110007_01&monitors=320310016_01&category=PM2.5_nowcast&centerlat=37.9074&centerlon=-122.6074&zoom=9

Monitoring “v4” site, 24 hr AQI detail



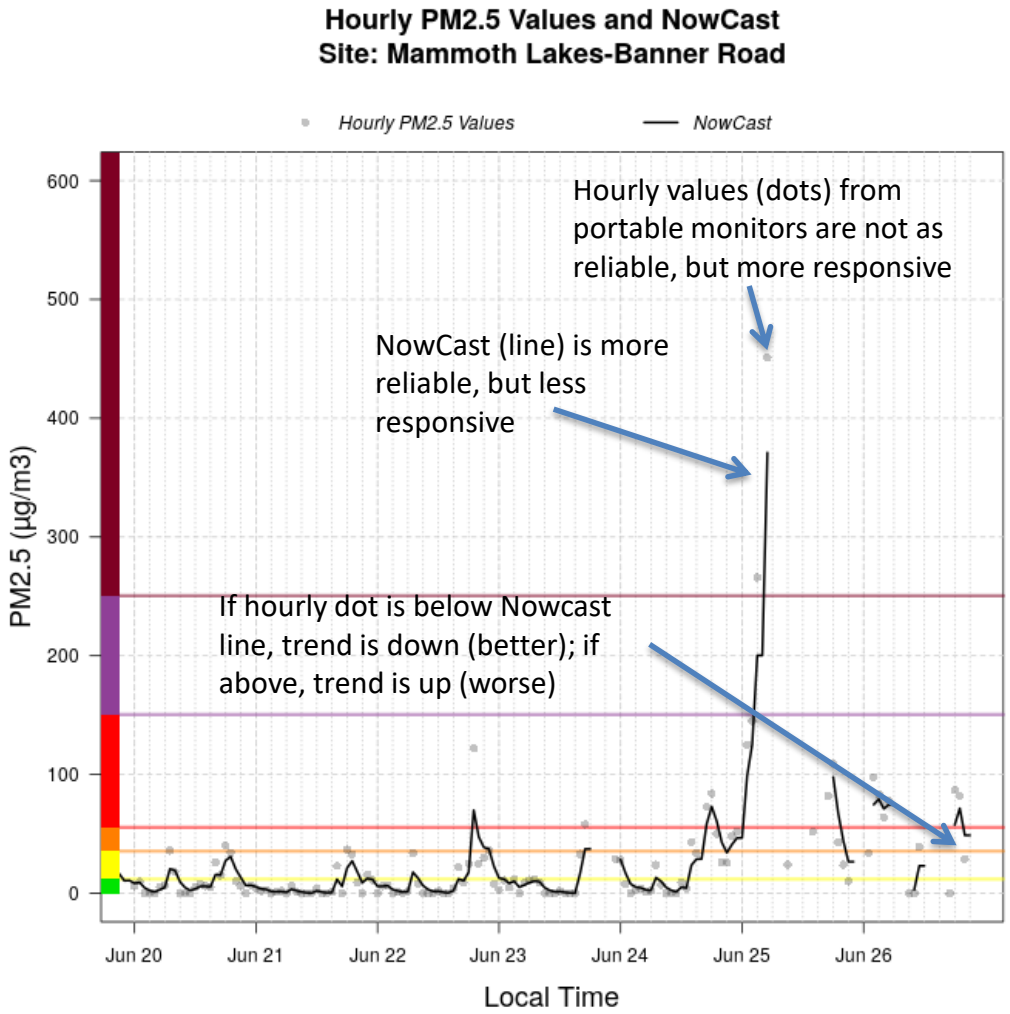
https://tools.airfire.org/monitoring/v4

Monitoring “v4” site, Baseline detail



https://tools.airfire.org/monitoring/v4

Monitoring “v4” site, hourly detail



https://tools.airfire.org/monitoring/v4

Exercise

- Do the monitoring data bear out the forecast from BlueSky for the Lion Fire?
  - Why or why not
  - Let's see what Rob Scott (current) thinks…
    - https://wildlandfiresmoke.net/outlooks/SouthernSierra

Messaging: ARA Smoke Outlooks: general information (1)

Smoke Outlook for 6/26 - 6/27
SouthernSierra Lions Fire
Issued at: 2018-06-26 21:40 UTC

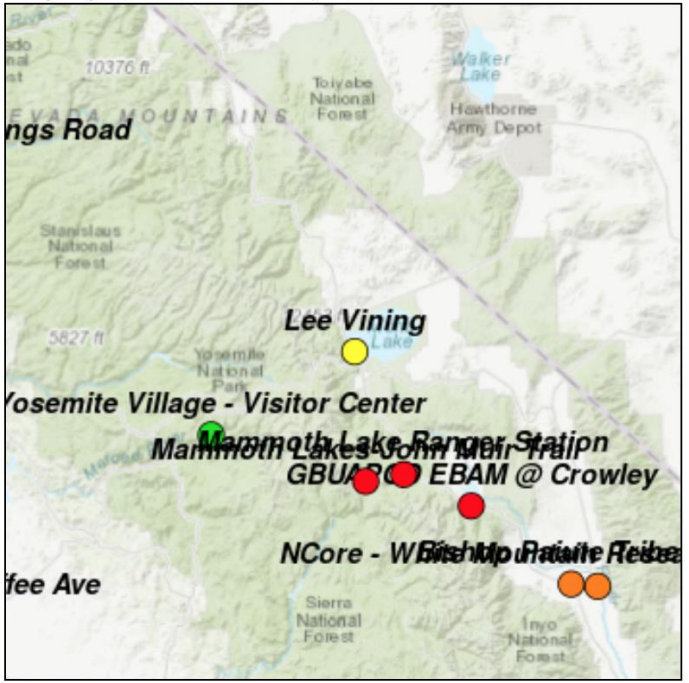
Outlook for SouthernSierra

Fire
The fire continues to actively consume heavy dead and down material. Limited movement is expected for the in the next few days. Firefighters are suppressing spots and active fire where they can safely approach the fires edge.

Smoke
Day time smoke conditions should improve today. However, as evening approaches, smoke contentions will deteriorate as winds decrease. Expect smoke levels that are 'Unhealthily for sensitive groups' in the Mammoth Lakes area tonight.

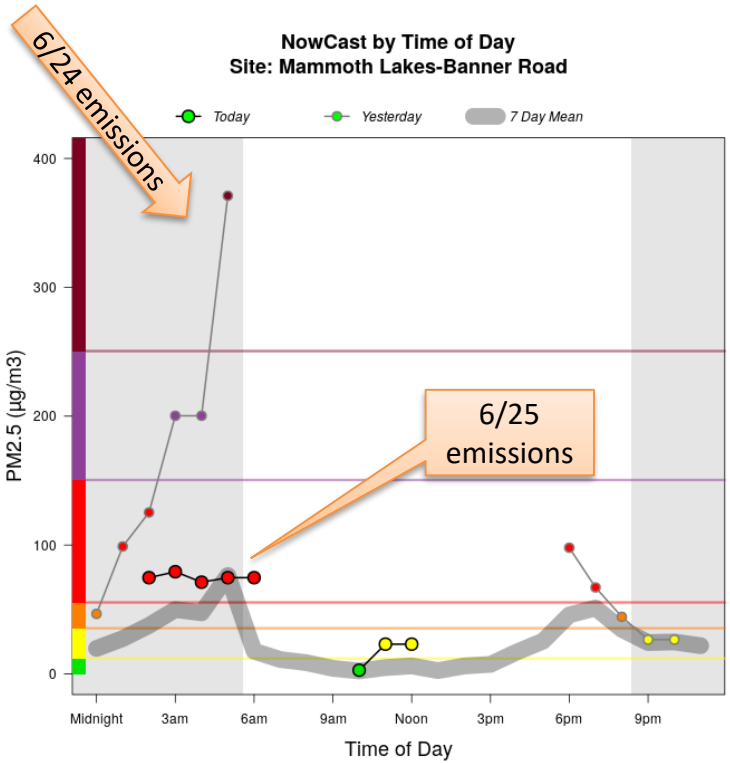
Weather
Warming and drying trend in forecast through Wednesday or Thursday. Afternoon temps in the mid 80s, RH in mid-teens and afternoon winds 10-15 mph, gusts to 30.

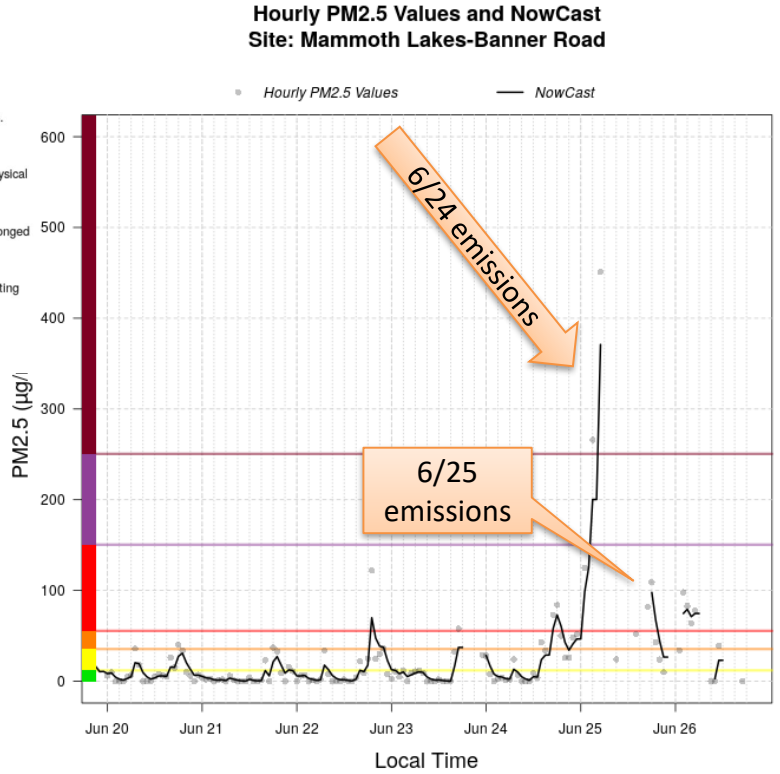
Daily AQI Forecast for Jun 26, 2018



Monitoring vs. Modeling:

Mammoth monitoring results

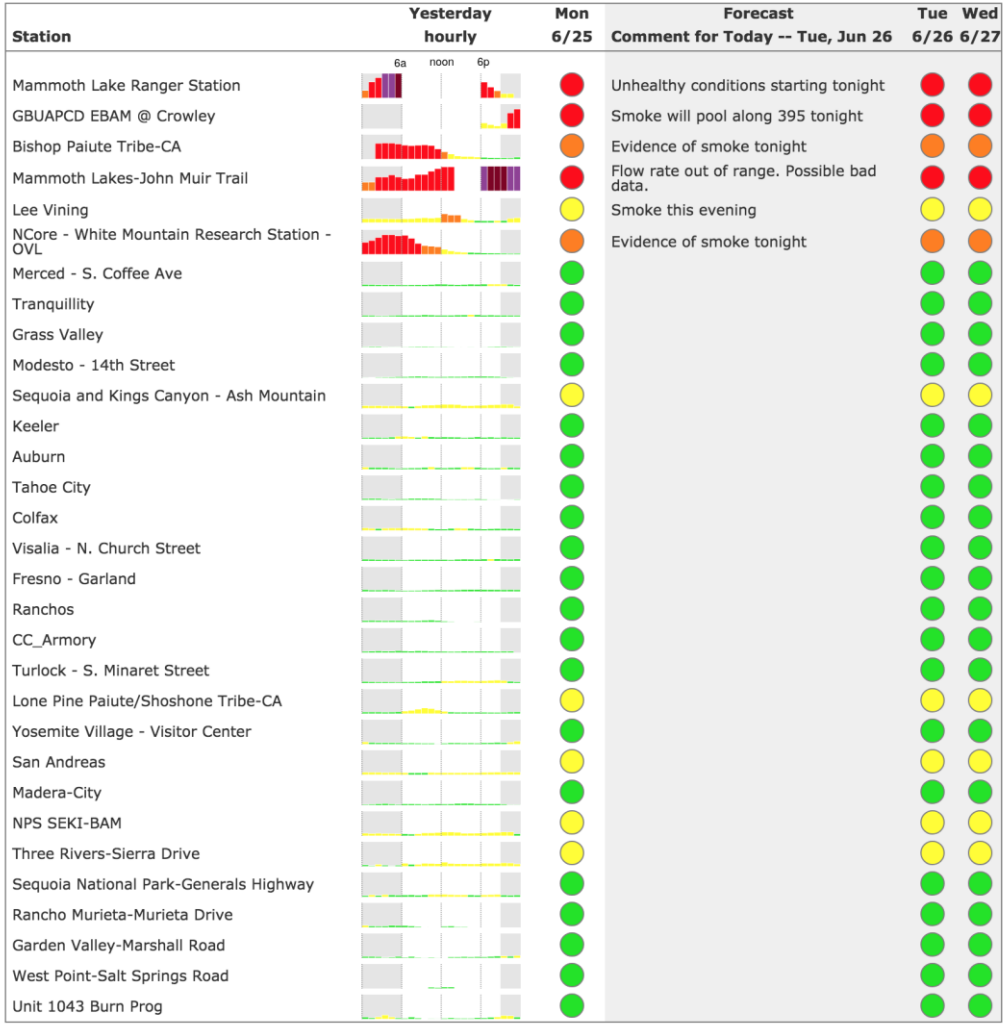




https://tools.airfire.org/monitoring/v4/#!/simple?monitorid=lon_.119.085_lat_37.630_usfs.1027&centerlat=undefined&centerlon=undefined&zoom=10&category=PM2.5_nowcast

Messaging: ARA Smoke Outlook and site-specific diel patterns

- Yesterday's pattern as a jumping off point for today and tomorrow
- Bubbles fcast the Daily AQI; bar graphs document yesterday's "nowcast" levels
- Text is best guess, based on ARA interp, of the likely pattern tomorrow
- The point is to help people plan activities around smoke

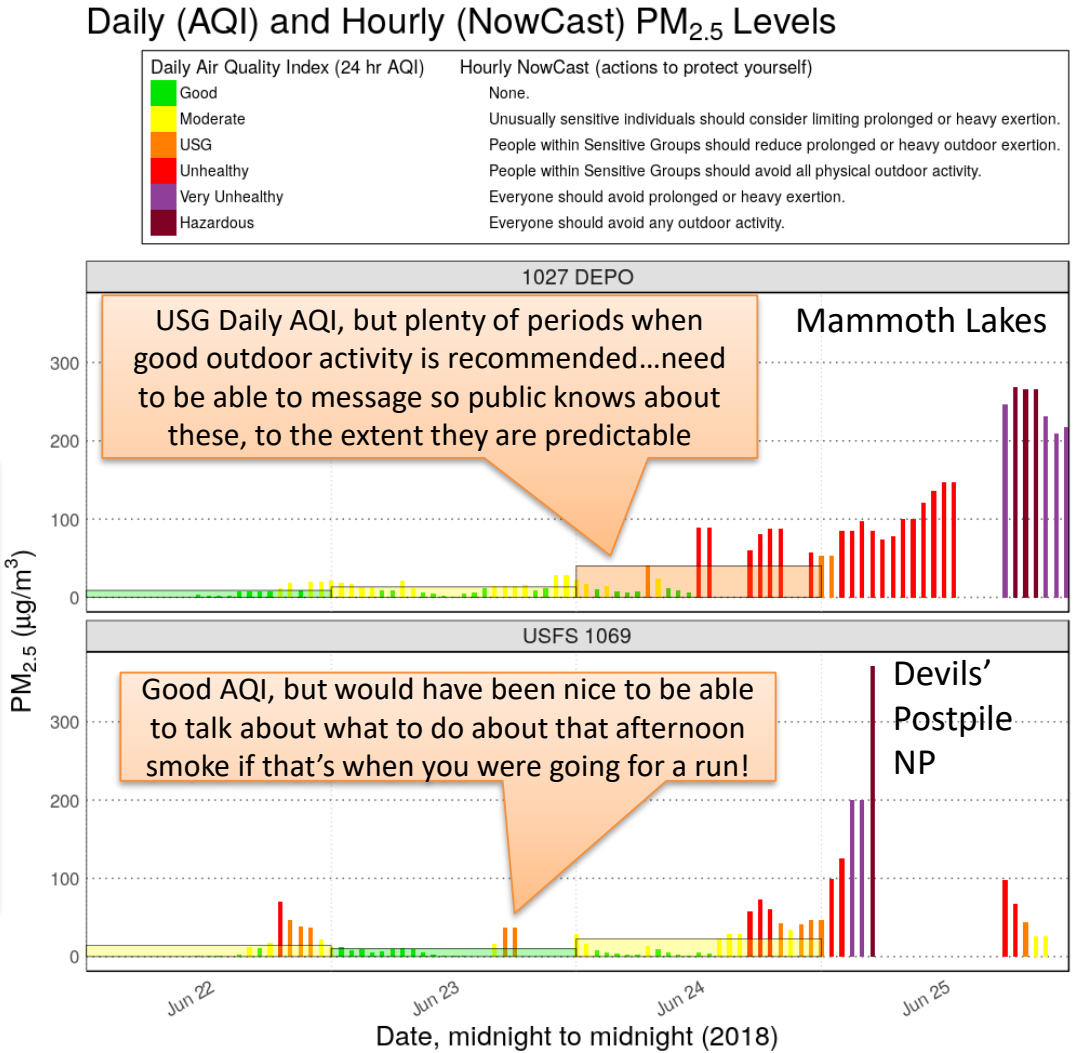


Issued 2018-06-26 21:40 UTC by Robert Scott

Why the 24 AQI is not enough

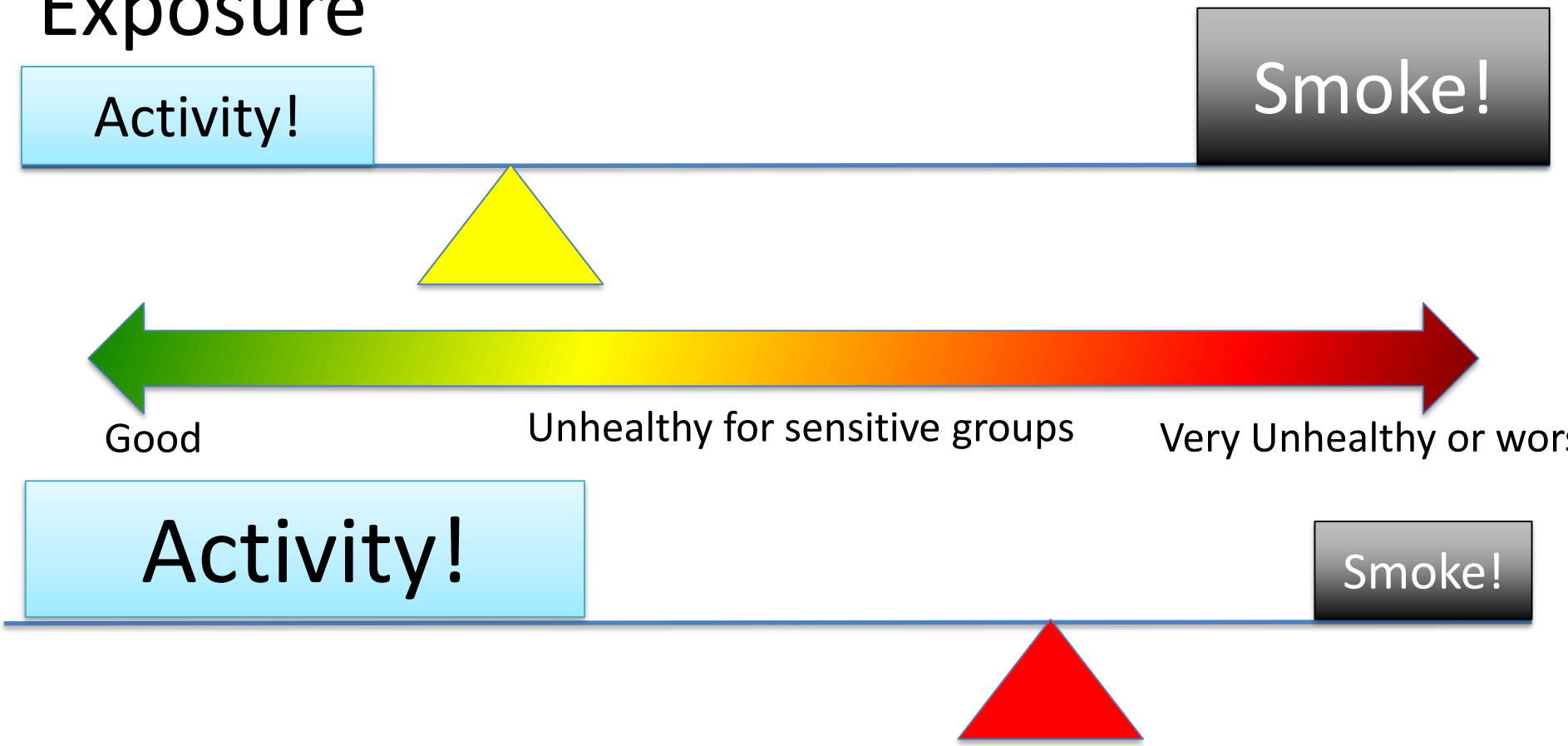
- Wildfire smoke is too variable for a 24 hr average to be useful for warning/avoiding smoke

This custom graphic is currently being tested, and should be available from the v4 monitoring site in the next couple weeks. This is a test URL, into which you can paste a text snippet to get current graph



https://test-c1.airfire.org/monitor-custom/v1/dailyhourlybarplot?monitors=lon_.119.085_lat_37.630_usfs.1027&monitors=lon_.118.961_lat_37.647_usfs.1069&outputfiletype=png&lookbackdays=5&width=10&height=7

Balancing Activity with Smoke Exposure



Messaging to empower the public to lower their own exposure

- Education on how to figure out when the smoke's coming (e.g., reading an outlook)
  - And other mitigations like clean rooms/buildings
- Maintaining specificity in forecasts so that smoky periods can be avoided/planned around
- Building experience between planned and unplanned fire
- Building Trust in the forecast through consistency
- Community that's resistant and resilient…there will be more smoke, one way or another.

Conclusions

- Specificity, builds